SCIENTIFIC AMERICAN SUPPLEMENT

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VOLUME LXXVII]
NUMBER 1990]

NEW YORK FEBRUARY 21, 1914

[10 CENTS A COPY
[$5.00 A YEAR

An installation affording a measure of water delivery. A Tony-Huber pump and accessories.

THE TESTING LABORATORY OF THE AUTOMOBILE CLUB OF FRANCE.—[See page 124.]

The Iron Blast Furnace and the Characteristics of Its Fuels—II*

Definition of Blast Furnace and Classification of Fuels Used

By J. E. Johnson, Jr.

Concluded from the SCIENTIFIC AMERICAN SUPPLEMENT No. 1989, Page 111, February 14, 1914

COKE AS A FURNACE FUEL.

COKE has many of the most desirable characteristics for a blast-furnace fuel. Well-made coke from good coal is always in large lumps, thereby supplying one of the fundamental requirements of a blast-furnace fuel. It has sufficient strength to resist breaking during the necessary handling which it undergoes both while it is being charged and during its descent through the furnace. It has a highly cellular structure which exposes the largest possible amount of surface per unit of weight. Consequently a very large amount of coke may be burned in a given area per unit of time, one of the necessities for rapid operation and high output of furnace.

The tarry constituents in the volatile matter of the original coal are completely destroyed by the coking operation, and there is, therefore, no tar to fill up the interstices in the charge and cut off the passage of the gases of combustion.

The worst objection to coke as a furnace fuel is its sulphur content. This varies from 0.6 per cent in the very best coke up to 2 per cent or more in inferior cokes. But when this limit is much excelled the fuel ceases to be suitable for the blast-furnace no matter how desirable it may be in other respects. In ordinary good cokes, the sulphur will vary from 0.8 to 1.5 per cent.

The second objection is its content of ash derived from the original coal; this varies from about 6 per cent in extraordinarily pure cokes to 18 or 20 per cent in poorer ones. Ordinary furnace fuels range in ash from 8 to 12 per cent.

Phosphorus is ordinarily low, generally under 0.05 per cent, but its amount is important because it all goes into the iron, and 0.03 per cent is the maximum amount allowed in some special grades of iron. As some phosphorus is always present in the ore and some in the flux, the amount in the coke is of great importance in such cases.

Sulphur can be removed to a very large extent by proper use of fluxes, but the melting of the slag resulting from the use of these fluxes requires more coke and therefore increases the cost of iron made from high-sulphur fuel. Similarly the ash which generally consists in large parts of silica has to be fluxed and this is objectionable for the same reason.

It is, of course, obvious that the more ash the less fixed carbon, and the fixed carbon is the only useful component of the coke. This ranges from 80 to 92 per cent, but good furnace cokes ordinarily contain from 85 to 90 per cent of fixed carbon.

CHARCOAL.

It is an interesting fact that the development of the manufacture of charcoal has been along a similar line to that of coke, there being three principal methods: Pits or meillers, beehived shaped ovens (ordinarily called kilns when used for charcoal), and retorts. There is no equivalent in the case of wood for the process in which distillation is performed for gas only and the resulting charcoal practically disregarded, as in the case of coal.

Charcoal is in general made from cord-wood, trunks and limbs of trees cut 4 feet long, and in good practice when more than 10 inches in diameter, split down to a size equivalent to an 8-inch stick. There are two general classes of woods recognized in charcoal manufacture known as "hard" and "soft." The principal hard woods are hickory, hard maple, beech, yellow birch and several varieties of oak, while the soft woods embrace principally the resinous woods, very commonly the yellow pine and allied species.

The production of soft-wood charcoal is smaller and less important than that of hard-wood charcoal and the value of the coal produced therefrom is less for furnace purposes, it being lighter and softer.

Pits.—In the production of charcoal by this method a space of ground about 30 feet in diameter is leveled off and on this wood is stacked up on end in the form of a truncated cone two lengths or 8 feet high, leaving a chimney through the center. The entire structure is than covered with earth and leaves and fired at the bottom of the chimney. A supply of air is admitted insufficient for complete combustion. The volatile matter is distilled off and burns, supplying the heat to keep the operation going. This continues for a week or ten days, when the wood is all charred and the process completed except the cooling off of the charcoal by standing covered.

There is, of course, some loss of charcoal through excessive air supply and as a result the yield of charcoal per cord of wood in this process is poor, nor is there any recovery of by-products. As a consequence of these disadvantages this process has gone out of use almost completely.

Kilns.—These constitute the next step in the development of charcoal production. They are built of red brick because only low temperatures are needed for the charring of wood and are very much larger than coke ovens, about 30 feet in diameter at the bottom tapering to about 24 feet at a height of 18 to 20 feet, the whole covered with a flat dome rising about 6 feet farther. They are provided with three rows of draft holes at regular intervals, one immediately at the bottom, one about 3 feet higher, and the third about 3 feet above the second. An opening through one side of the dome, about 5 feet square, is provided through which they are charged, and a door about 5 feet wide and 6 feet high at the bottom through which the charcoal is removed, also an opening at the bottom on one side which communicates by a short chimney with a smoke main. They are also provided with a small hole about one foot in diameter in the center of the dome.

These kilns are filled with wood to the top, the wood being piled as uniformly and smoothly as possible with a stack up through the center. Fire is started at the base of the stack and the large top and side openings are then closed with thin steel plate doors and luted air-tight. The fire is permitted to burn very slowly with natural draft through the hole in the top of the dome for a few hours. This opening is then closed and the kiln is connected with the smoke main, on which suction is maintained by a system of fans. The draft is carefully regulated, the bottom row of holes being used first and the higher ones later in the operation. At the end of about 10 days most of the volatile matter is distilled off, then the kiln is disconnected from the main, the draft holes are sealed up air-tight and the kiln is allowed to stand for a period of 10 to 20 days in order to cool the charcoal well below the ignition point.

Charcoal is extremely inflammable. It will ignite spontaneously even at atmospheric temperature under certain conditions; presumably, on account of its very great power of absorbing gases, the action would seem to be not unlike that of spongy platinum in igniting hydrogen.

The situation is further complicated by the fact that the use of water to extinguish fires in this fuel is highly objectionable. Charcoal absorbs vast quantities of water which appear not to be driven off except at a very high temperature so that the charcoal seems to descend almost to the hearth of the furnace still containing water, and the effect of such water is exactly the same as if introduced at the tuyeres.

On this account, charcoal must be cooled with great thoroughness before exposure to the air.

After the coal has been properly cooled all the doors are opened, and the buggies which are to deliver the charcoal to the furnace are taken into the kiln and there loaded.

The shrinkage during the charring operation is very great, about 50 per cent, so that while the kilns are filled with wood they are only about half full of charcoal when opened.

The smoke drawn off through the mains by the fans as above described is subjected to cooling and scrubbing whereby its volatile constituents are removed and recovered, but in a very dilute condition because of the great quantity of water vapor in the smoke which comes from the water of the wood, because thoroughly seasoned wood contains about 50 per cent water. Of the other 50 per cent about one-half is charcoal and one-half volatile matter. Unseasoned wood contains much more water than this.

The valuable by-products in the case of wood are methyl alcohol, acetic acid and wood tar. The last is not so valuable industrially as coal tar and for that reason is commonly used only as a fuel to aid in the distillation process. The wood alcohol is obtained first in the form of a 2½ per cent solution. This is rectified by distillation up to 95 per cent or more. It is perfectly possible to make it chemically pure by proper distillation and a little chemical treatment.

The acetic acid cannot be recovered by distillation because its boiling point is too close to that of water and the two substances dissolve one another thoroughly in all proportions. The acetic acid is therefore recovered by neutralizing it with a mineral base, commonly lime, which forms a soluble but non-volatile acetate. This is recovered by evaporation of the water.

The Retort Charcoal Process.—This process is very similar to the by-product coking process, but on account of the lower temperature the retort is built of steel instead of firebrick. It consists of a steel chamber, roughly, 6 feet wide by 8 feet high and 50 feet long, surrounded with a brick setting and provided with a firebox under each end. A stack is provided to draw the products of combustion from the fireboxes around the retort. These retorts are charged with eight cords of wood on four-wheel trucks built of steel slats. The retort is closed at both ends by air-tight steel doors and is provided with an outlet for the volatile products of distillation.

After charging, the doors at both ends are closed and fires built in the fireboxes. The gas outlet is connected to a water-cooled condenser and all the volatile products are condensed therein. The non-volatile gases are highly combustible and are led back under the retort to assist in supplying the heat it requires. In about 20 to 24 hours the process is complete, the doors are opened, the trucks containing the charcoal are withdrawn and immediately replaced by others containing a fresh charge of wood. The doors are then closed again and the process repeated.

The trucks containing the charcoal are drawn as rapidly as possible into the coolers, which are steel chambers exactly like the retorts in general shape and size, but more lightly constructed and set out of doors so as to get the maximum cooling effect. There are two of these to each retort set in line with it and separated from it and from each other by a short open space. The charcoal is put first into the nearest one and there allowed to cool for 24 hours, and at the next drawing of the retort it is moved into the second one, the fresh charge being put into the first cooler.

On account of the rapidity with which charcoal burns on exposure to the air, the transfers, particularly the one from the retort to the first cooler when the charcoal is very hot, are made as quickly as possible and the air-tight doors of the coolers are immediately closed so that no air can reach the charcoal. Even with these precautions and with an additional cooling of 24 hours in open air, fires by spontaneous combustion of the coal are not infrequent.

This process gives much better yields of by-products than the kiln process. The latter in good practice yields 4 to 5 gallons of refined methyl alcohol and 85 to 100 pounds of acetate of lime per cord of wood. The retort process yields in good practice 9 to 10 gallons of refined alcohol and 170 to 220 pounds of acetate of lime.

The reason that this great superiority in the yield of valuable by-products has not forced the introduction of the retort more rapidly is that it suffers under two disadvantages. First, the cost of plant per cord of wood carbonized is about three times that of the kiln plant, and for large capacity it runs into such a heavy expenditure as to put these plants out of the reach of any but relatively large and wealthy corporations. Second, the maintenance charges of the retorts and plant generally are very heavy, the bottoms are liable to be burned out by a few hours careless firing and the retort as a whole may be warped so as to be worthless without heavy repairs, unless it is managed with great skill.

Those who have installed and managed retort plants with skill and intelligent care think that they constitute the only method of wood distillation worthy of consideration, while those who have operated them carelessly and ignorantly declare with equal positiveness that from a commercial point of view they are inferior to kilns, in spite of the much lower yields of the latter, which are undoubtedly very much easier to manage.

The yield of charcoal in the two cases is not very different, about 50 bushels of 20 pounds to the bushel per cord of wood.

It is probable, however, that this comparison is not quite fair to the retort because it can and does drive off the volatile products more thoroughly than the kiln can do without waste of coal by combustion, so that while the weight of charcoal is about the same in the two cases the fixed carbon in the retort coal is greater than that of the kiln coal.

This is partly compensated in the opinion of some operators by the fact that the retort coal is more brittle and therefore breaks up worse in the furnace than the kiln coal. Such personal experience as I have had tends

* Reproduced from *Metallurgical and Chemical Engineer.*

to contradict this view as I have found that better fuel economy was obtained with retort than with kiln coal.

In a large-scale charcoal operation, the difficulty of obtaining an adequate and steady supply of cord wood is very great. The yield of cord wood per acre of timber land is from 5 to 10 cords when only the material unsuitable for saw timber is taken, and 40 to 50 cords per acre when all the timber is taken. The former condition is the more common and for this reason areas of several square miles must be cut over per year to supply a large charcoal operation. This makes many transportation difficulties.

In the earlier days of the industry, small batteries of kilns were built close to the timber supply and the charcoal was shipped from these to the furnace, no attempt being made to recover the by-products. When commercial conditions forced the abandonment of this wasteful procedure the small batteries of kilns in the woods were abandoned and one large central battery was built preferably at the furnace, because the labor of handling the finished charcoal and its consequent breakage were reduced to a minimum, and, what is equally important, the waste gases of the furnace became available to supply steam for the great amount of distillation involved in the recovery of the by-products.

In those cases in which retorts are installed, the same considerations hold, and such plants are located at sites where timber may be shipped to them by rail from a large territory. Very frequently these also are located at the furnaces which consume their coal, but not necessarily, because owing to the greater profit on their by-products they can sell their coal more cheaply than can the kiln plants and can, therefore, deliver it over considerable distances in competition with kilns.

Methyl alcohol is worth at the plant from 25 cents to about 40 cents per gallon, depending on the location and the perfection of the rectification.

Acetate of lime is worth from 2 to 2¾ cents per pound at the plant, depending upon the state of the market.

The cost of recovery with properly designed plants is low, and therefore the income received from these by-products has a very important commercial bearing on charcoal production. In fact, the charcoal is the real by-product at many of these plants and the furnace is built simply as the most convenient means to consume this fuel.

CHARCOAL AS A FURNACE FUEL.

Charcoal is almost an ideal furnace fuel. It is nearly free from sulphur, having only a few hundredths of one per cent as against approximately one per cent in coke and about one per cent of ash against about ten per cent for coke. Moreover, this ash consists very largely of lime and alkalis, so that it supplies a part of the flux required for the gangue of the ore instead of being largely silica and requiring to be fluxed with additional bases as is the case with coke.

Charcoal has a highly porous structure and can therefore be burned at a rapid rate per square foot of hearth area. This fuel, however, is subject to one drawback. It has not quite the physical strength of coke and would perhaps be unable to stand the conditions existing in a large furnace. On the other hand, owing to the difficulties of wood supply above mentioned, charcoal furnaces are always small as compared with coke furnaces, and therefore the necessity of its having to withstand the pressures customary with large furnaces does not arise.

Charcoal has one bad characteristic not widely appreciated. In spite of its low ash (about one per cent) its percentage in fixed carbon is very low, only about 69 per cent or less in kiln coal. The remainder, about 30 per cent, is volatile matter which is not driven off at any heat which it is permissible to use in charcoal distillation. This volatile matter is about one half hydrogen and of the remainder a large portion consists of gases of high reducing power, methane and CO among the number.

Because of these valuable characteristics, the fuel per ton of iron produced is less with charcoal than with coke. These matters will be more fully discussed in a subsequent article.

ANTHRACITE COAL.

Anthracite coal has about the same chemical analysis as good coke for the reason that it is simply bituminous coal whose volatile matter has been distilled off under conditions of heat and pressure arising from the geological movements of the earth's crust. The pressure has closed up the cells as they were formed and anthracite instead of being cellular like coke is in fact the most close grained of any variety of coal. It only occurs in quantities of commercial importance in a small district in eastern Pennsylvania in the United States, though small deposits are known elsewhere, and deposits of much importance occur in Wales in Great Britain.

Owing to its abundance and cheapness in the early days of the industrial development of the United States, it was the principal fuel used in the blast furnace until about 1860, when the development of the coking process began to furnish a rival fuel. As the magnetite mines of New Jersey and the limonite mines of eastern Pennsylvania are in close proximity to the anthracite coal fields, a great iron industry was developed based upon these materials.

But the increasing use of anthracite as a domestic fuel enhanced its value, while the development of the blast furnace proved coke to be the better fuel of the two for its purpose. The anthracite iron industry, therefore, declined, and there are only a few small furnaces using this fuel exclusively, though in the eastern Pennsylvania district, where it is cheaper than good coke, a certain amount of it continues to be used in admixture with coke to lower the cost of the fuel charge.

ANTHRACITE AS A FURNACE FUEL.

Anthracite has three disadvantages as a blast-furnace fuel when compared with coke.

First, it is entirely lacking in cellular structure and is simultaneously of much greater density, so that the ratio of surface exposed per unit of weight is only a small fraction of what it is in the case of coke, and only a proportionately small amount can be burned per square foot of hearth area. This means that the output of a given furnace is necessarily much smaller when supplied with anthracite fuel than with coke.

Second, it has a tendency to spall or decrepitate under the action of heat. As a consequence of this spalling action the interstices through the fuel which form the principal passageway for the gases are greatly obstructed and the pressure required to drive the gases through the furnace is much increased. Moreover, this spalling seems to produce a tendency to scaffold the furnace, which will not be discussed here.

Third, the much greater density of the fuel as compared with coke reduces the volume of the fuel charge very greatly. This increases the density of the charge as a whole and permits a longer time for the passage of the ore through a furnace of given size. But for the reason already mentioned above this advantage is useless in increasing the output. On the other hand, the increased density of the charge means increased resistance to the blast.

As a consequence of these three conditions anthracite furnaces are characterized by slow driving and small outputs, high pressure, and a strong tendency to become scaffolded and work irregularly. These are the technical conditions which, joined with the commercial considerations above outlined, have caused the decline of anthracite as a blast-furnace fuel.

RAW COAL.

Certain coals, called "bituminous" for lack of a more descriptive name, while they contain a normal amount of volatile matter, are largely free from tarry ingredients. These are known as "dry" bituminous coals. On account of their relative freedom from tarry matter these fuels fall within the fundamental requirements of a blast-furnace fuel and in the past were quite extensively used as such.

But the development of the coke blast-furnace has caused a retrogression in the use of this fuel very similar to that in the case of anthracite. In certain districts where these coals may be obtained cheaply and for the production of certain special irons they are still used in admixture with coke. But so far as known to me there are no furnaces now running in the United States on raw coal fuel exclusively.

RAW COAL AS A FURNACE FUEL.

A lack of porosity and the consequent slow rate of combustion of these coals are presumably the principal reasons for the decline in the use of this fuel. Moreover, though these coals are relatively dry they are not entirely free from tarry matter, and as but a small quantity of tar is required to obstruct the passage of the gas, this also has tended to reduce the rate of driving possible with this fuel. Moreover, the tendency for the furnace to scaffold and work irregularly even with a small amount of tarry matter present in these coals is pronounced. Their use is, therefore, generally confined to a district in southern Ohio, where they occur and are applied in admixture with coke to the production of an iron containing 15 to 20 per cent of silicon and known as ferro-silicon.

The characteristics of these fuels have modified furnace practice, and this in turn has modified equipment and product, so that the classification of iron by the fuels used in their production is fully justified. But as will be seen from what has already been said, the only units in the classification which have preserved their individuality unchanged are coke and charcoal, the only two varieties of iron now in common commercial use.

ADDITIONAL REQUIREMENTS.

We have given a definition of the fundamental requirements of the blast furnace. To these may be added two more, which are necessities in the case of more than 99 per cent of the iron produced.

First, the slag must be sufficiently fusible to run freely from the hearth at a temperature easily attainable.

Second, the blast must be warmed before being delivered to the furnace.

The single exception to these two conditions occurs in the case of furnaces making cold-blast charcoal iron, of which probably not over twenty or twenty-five thousand tons per year are produced out of a total of some thirty-five millions tons in the United States. In this case the temperature attainable is very low and in consequence the slag is not heated hot enough to run freely and has to be removed from the furnace with the assistance of mechanical means such as slag-hooks, etc., or, if it comes from the furnace without assistance, it chills before going more than a few feet and is accordingly troublesome to remove.

Leaving out of account this very small percentage, all blast furnaces are blown with blast heated from 500 deg. to 1,400 deg. Fahr., and their slag is heated to a degree sufficient to enable it to run from the furnace without assistance and far enough to reach some convenient means of ultimate disposal. The heated blast was introduced by the Englishman, Neilson, about 100 years ago, and it has made possible the modern development of the blast-furnace because the velocity of combustion of the fuel is so greatly augmented by preheating the blast, and the continuity of the operation has so increased by raising the molten iron and slag well above their fusion points, that outputs have been increased almost a hundred fold since.

The iron blast furnace is now probably the largest industrial apparatus in use, not only in size of plant, but in the quantity of raw materials consumed and output. Furnaces have often been built which produced 600 tons of iron per day, but modern practice tends to slightly smaller units, furnaces now being built only for an output of about 500 tons per day; but this is maintained as an average output for months and years together.

To produce a ton of iron under favorable conditions requires about 2 tons of ore, ½ ton of flux, 1 ton of fuel and about 4 tons of blast; greater quantities are required when the conditions are less favorable. With each ton of iron is also produced about 6 tons of waste gases and about ½ ton of slag, this, as well as the iron, being handled in the liquid condition. For a 500-ton furnace we have, therefore, to handle every twenty-four hours about 1,700 tons of solids, 750 tons of white-hot liquid and 5,000 tons of hot gases (blast and waste gases together).

To do this on an industrial scale and with a labor cost amounting in good practice to less than 75 cents per ton, a great plant is necessary. Such a plant must contain the following parts: First: The shaft furnace itself, through which the entire mass of material just mentioned passes, the solids passing down to the liquid condition at the bottom and the gases upward through them. Second: Means for handling the raw materials, ore, fuel, flux, proportioning them properly and delivering them in certain accurate and positive relations into the top of the furnace. Third: Means for raising the atmospheric air to a pressure sufficient to force it through the furnace in the quantity desired. Fourth: Means for heating this supply of air uniformly and regularly to the temperature desired. Fifth: Means for handling the molten iron on its discharge from the furnace and turning it into a commercially salable product. Sixth: Means for removing the slag from the vicinity of the furnace. Seventh: Means for removing the gases from the top of the furnace and (as these gases are a valuable fuel) for leading them to those portions of the plant where they can supply the energy for compressing the blast and heating it. There is an eighth requirement not embodied in our fundamental definition, but which has become an absolute necessity notwithstanding; a supply of water for cooling certain parts of the furnace and preventing the intense heat inside from destroying the structure.

Boiling Carbon

At a recent meeting of the Silesian Society of National Culture, Dr. O. Lummer, professor of physics at Breslau University, read a most interesting paper on the liquefaction and ebullition of carbon. The author, in his experiments, used different sorts of coal, among others a graphite coal containing about 1 per cent ashes and an especially pure Upper Silesian coal whose percentage of ashes only was 15 per cent. All these coals exhibited an identical behavior.

If the coal be introduced into an electric flame arc at 220 volts tension, while reducing the pressure, it begins boiling at a pressure of 50 to 60 centimeters. Below 50 centimeters pressure, the coal becomes a tough liquid, and at 40 centimeters it is entirely liquid. However, so far from dripping off, it forms bubbles and finally boiling pearls, which afterward, on account of the great crystallizing power of carbon, show an angular appearance. At a pressure of slightly over 10 centimeters, boiling ceases, there being only left some vapors rising from the edges until the carbon, as the pressure goes on falling, again becomes solid.

The product obtained after boiling is graphite. Further experiments with chemically pure carbon are in course of preparation, the results of which will have to be waited for in order properly to account for these phenomena.

The Commercial Uses of Bamboo

There is Hardly a Country in the World Where the Plant is Not Employed for Various Purposes.

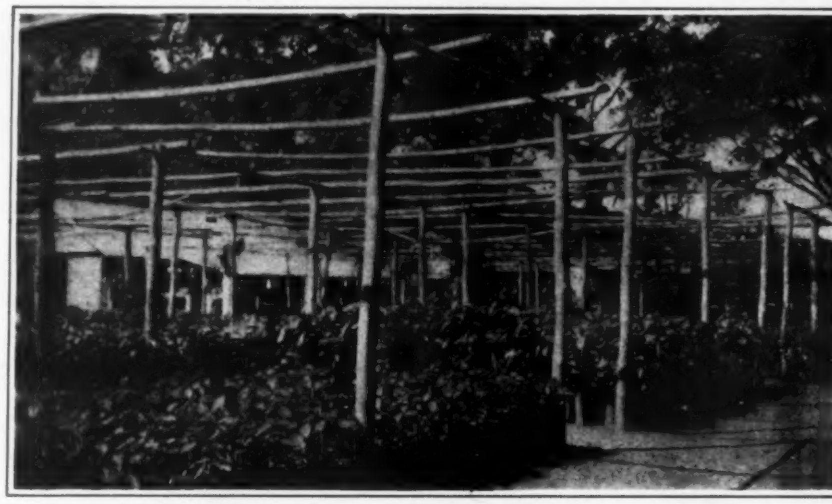
The bamboo is a tree-like grass of great economical importance. It grows abundantly everywhere throughout the tropics and varies in luxuriance according to the soil and climate. A few species occasionally attain the height of 60 or 70 feet in a single season. The bamboo is generally regarded as a plant found only in the tropical parts of southern Asia. Notwithstanding the popular notion to the contrary, some of the largest kinds thrive very successfully in the poorer soils where the snows are sometimes so heavy as to break down the young stems. It is extensively cultivated in the cooler latitudes where it shoots up with great rapidity, and a number of varieties have been introduced into the United States, as well as into England and many parts of Europe. While the most important varieties are natives of China and India, a number offer a splendid opportunity for planting in a commercial way in the temperate climates of other countries.

The most beautiful bamboos in the world are peculiar to China. They attain to their full height of from 60 to 80 feet in a few months. Actual measurements have shown that some of these shoot up from two to two and a half feet in 24 hours. Unlike the bushy bamboos of India, with their conspicuous joints and branches throughout their length, the tested varieties in China usually present a clear surface for 30 feet or more from the ground. The freedom from knots and the fineness of their structure render the wood of great importance in the arts.

The bamboo is propagated largely from suckers, but it is important after a time to renew the old plants from the seed, since the old stalks die down to the root like all other grasses, after they flower. It is rather difficult to transplant, but after it is once thoroughly rooted the young shoots increase in number in the same way as in basket willow. Old healthy clumps often produce as many as a hundred stalks. The size of the stalks can be increased by cutting off the shoots and by covering the old stumps with sulphur for several years, after which the shoots will spring up with increased vigor and attain greater proportions. Certain varieties when properly treated will make splendid hedges, and in many parts are used extensively for wind breaks. No plant adds so rural and oriental an aspect to a country home as several clumps of bamboo suitably located in the lawn. This graceful and stately grass forms innumerable plumes which sway to and fro in the slightest breeze, forming an object of beauty as well as usefulness.

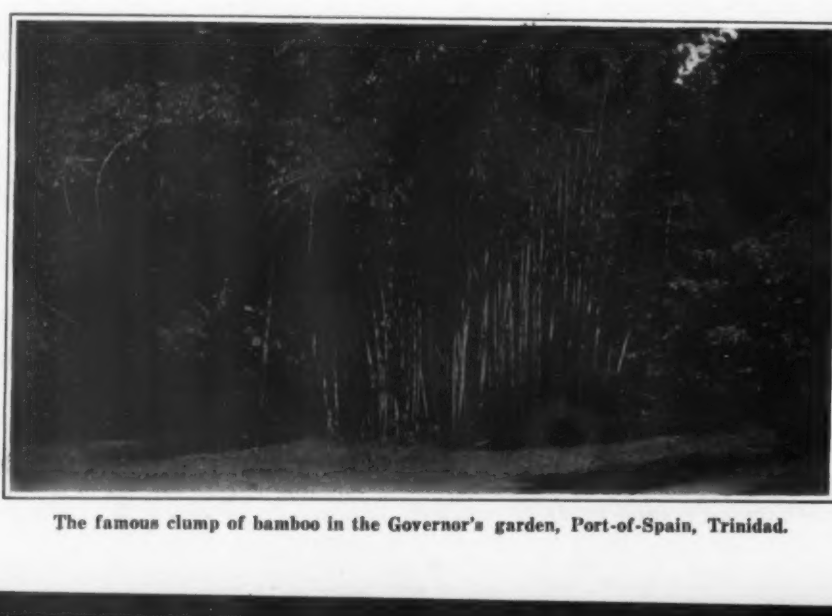
The bamboo may well be called useful. One writer states that China could hardly be governed without the constant application of the bamboo, nor the people carry on their daily pursuits without it. The uses among the people in the East are so numerous as to entitle this grass to be called the national plant of the Chinese. There is hardly a country in the world where bamboo is not now used for some purposes or other. Where this plant cannot be made to grow, the bamboo stems form an article of import to a greater or less extent. While a good many varieties of bamboo are grown successfully in southern Europe and in parts of the United States, large quantities of the wood are imported from Japan for multifarious uses. Every year several million bamboo fishing rods are shipped into the United States. Besides this material enormous quantities are brought here from Japan for making walking sticks and furniture.

A number of countries in which bamboo does not grow naturally have contended for the honor of making greatest use of bamboo wood. Germany, France, England and the United States are the principal claimants. Of the four countries named, Germany would seem to have the balance of testimony on its side. Novelties made from bamboo are by no means of rare occurrence in the United States, and are now so multifarious as to defy enumeration. Practically all Central and South American republics find an immense number of uses for this wood. In view of the steadily increasing demand for tropical woods and the lack of systematic methods to renew the supply of their best timber trees, the general introduction and cultivation of bamboo, and the increased use of its wood, seems to be opportune. The bamboo is a tree which can be planted with a complete assurance of commercial success, if the plantation is properly established and given proper care. It does not take a life time to get results. Bamboo will grow to its greatest size in six years. In half that time it will attain sufficient size for most uses to which it is put. After the bamboo has been cut it will reproduce immediately by means of young shoots sprouting from the old stumps, and this production is constant and almost unending.



Cocoa nursery in Trinidad. The pots in which the young plants are raised are made of sections of bamboo stems.

Bamboo planted by the Dutch in the eighteenth century, near Bartica, British Guiana, South America.



The famous clump of bamboo in the Governor's garden, Port-of-Spain, Trinidad.

Most of the species of bamboo have hollow stems, which often attain a diameter of from 6 to 8 inches and sometimes from 50 to 100 feet in height. The fact that the stems are hollow renders them very light, and at the same time exceedingly strong, so that they can be used for a greater variety of purposes than the white pine of the eastern United States. It is used for construction purposes and forms the posts and frames of the roofs of huts, scaffoldings for large buildings, rafts, masts, spars, oars, decks of boats, and, in fact, entire boats and dwellings are made of the stems. Practically every part necessary in the construction of a house is made of bamboo. It is used also for building bridges across rivers, for fences, and for flag poles. A number of agricultural implements are made of it, as also small carts, litters used in China, biers, spears, bows, arrows, clubs and fishing rods. Ornamental inlaid work is constructed from it, and the entire stem, from its combined lightness and strength, answers every purpose for which poles can be employed.

One of the early and most important uses of bamboo was for the making of paper. The tough paper of the Chinese is made by beating the young shoots flat, steeping in lime for a month, and then washing and drying. Paper made in this manner has been used for centuries. By proper treatment, the young stems can be split, and rendered soft and pliable so that they can be ingeniously plaited and worked up into wearing apparel. Curious undershirts are made in this manner to be worn during hot weather.

There are innumerable other minor uses which bamboo serves in the East, and to some extent in other countries as well. A joint of bamboo is used as a holder for pens, small instruments and tools. It has been used in nearly all civilized countries as a case in which things of little bulk are sent through the mails. It also answers the purposes of a bottle and as measures for liquids, rice, etc. In India and, in fact, in Europe and the United States these joints are employed by nurserymen and florists in which to raise young plants. When these are ready to be transplanted, the joints are easily split and separated before the plants are set in their permanent places. The outer covering of bamboo stems is very hard and flinty, and almost fire-proof. It serves the purpose of a whetstone for sharpening sickles and bill hooks.

The split ends of suitable stems are used for fire tongs, and certain kinds serve as blow-pipes and tubes in distilling plants.

The smooth outer portion of the bamboo stems is peeled off by means of special machinery, and these thin strips are used for a great variety of purposes. There is no other material, except it is that of rattan, that is quite so strong as these strips made out of bamboo stems. They are very flexible, and can be readily twisted and bent into any conceivable fashion. Ropes, baskets, buckets, trays, sieves, awnings and matting, and even furniture, are woven out of these thin strips, which are exceedingly durable and stand more wear and tear than any other vegetable product. The leaves of the bamboo have a great many uses. They are sewn upon cords in layers to make rain coats and numerous other wearing apparel.

The joints may be used as cooking utensils in the woods. The food to be cooked is placed in the hollow of the stem, and after the opening at one end is closed with a bundle of bamboo leaves, the other end, which is closed naturally at the node, is placed over the fire. The silicious coating of the green stem or cane resists the action of the flames sufficiently long until the food is cooked. It is said that this is a favored method of cooking the food by hunters and woodsmen, since it retains the delicate flavor of the food.

Social Evolution in Wasps*

Its Development Corresponds to That of Anatomical Characters

By J. Penau

It is well known that a remarkable gradation of the social instinct is exhibited by various species of bees, from the solitary bee, which laboriously constructs a few brood cells in a crevice of a wall or an abandoned snail shell, to the marvelous honey bee; but it is less generally known that a similar social evolution can be observed in wasps.

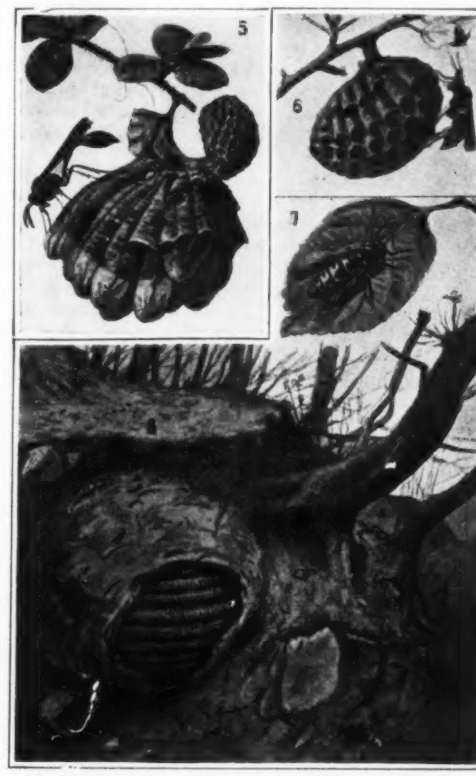
* Reproduced from *La Nature*.

At the bottom of the social ladder stand the species known as solitary wasps, in which each female builds and provisions a home for her own offspring, which by the way, she will never see, for she is doomed to die before they are hatched. The nest of one species, *Eumenes coarctatus*, of southern Europe, is composed of a single cell, attached to a wall, leaf or branch, and built up of pellets of earth, moistened with saliva. At first the cell has a regular and nearly spheroidal form, resembling a little vase, about ½ inch broad and ⅓ inch high. In this cell the expectant mother collects a store of small caterpillars, which she paralyses, without killing, by stinging their nerve centers. She then lays one egg, which she suspends by a thread from the top of the cell. Finally,

Figs. 1, 2, 3.—Solitary wasps and their nests. 1. Eumenes coarctatus. 2. Eumenes unguiculus. 3. Odynerus spinipes.

Fig. 9.—Vespa media.

Fig. 4.—Chalonites abbreviatus.



Figs. 5, 6, 7, 8.—Monogamous social wasps and their nests. 5. Belenogaster junceus. 6. Polistes gallicus. 7, 8. Vespa germanica.

Fig. 10.—Nest of Vespa media.

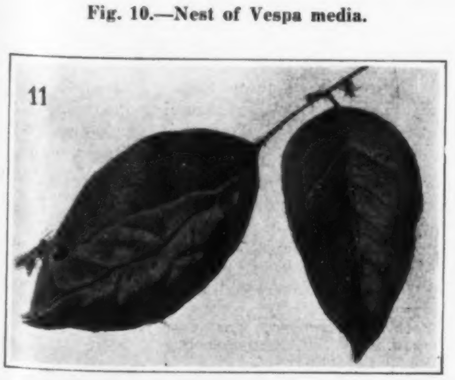


Fig. 11.—Leipomeles lamellaris.

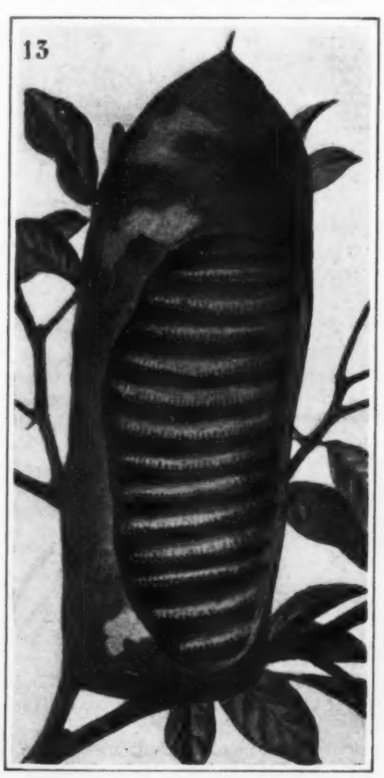


Fig. 13.—Polybia dimidiata.

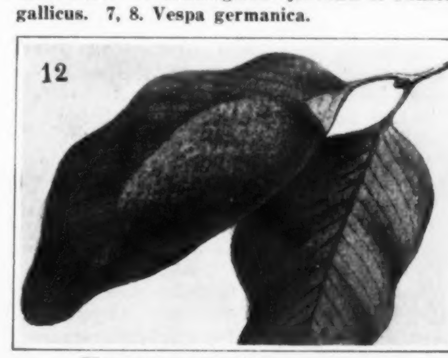


Fig. 12.—Protopolybia emortualis.

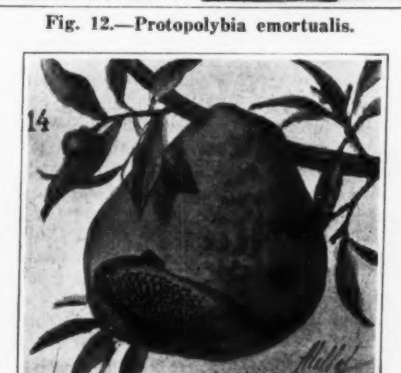


Fig. 14.—Polybia rejecta.

she destroys and closes the neck, completely covers the pretty little vase with a shapeless layer of mortar, and departs, leaving the egg to hatch and the larva to feed and undergo metamorphosis unaided.

A kindred species, *Eumenes unguiculus*, of central and southern Europe, shows a slight advance. The nest is composed of several cells, inclosed in a common shell of mortar. This economy of labor in construction enables one female to lay a number of eggs.

Another solitary European wasp, *Odynerus spinipes*, makes its nest in the ground. Many females may be digging side by side, but each works for herself and, in case of danger, defends her own nest alone. She selects a hillside facing east or south, burrows to a depth of 4 or 5 inches, often in soil so hard that she is compelled to moisten it with saliva, and utilizes the extracted material in the construction of a sort of chimney, 8 to 12 inches high, around the orifice. After provisioning the nest with paralyzed larvæ, and laying, she destroys the chimney and closes the orifice with other material.

The three species that have been described belong to the family *Eumenides*. Less common forms, of very different habits, are found in another family of solitary wasps, the *Masarides*, which are honey gatherers, and not carnivorous.

Ceramius lusitanicus, a native of southern Europe, constructs an underground burrow about 2½ inches long, surmounted by a chimney and terminating in an ovoid chamber, 1 inch long and ½ inch wide, which is stocked with coarse honey and a single egg. This species feeds its young larvæ—a notable social advance. Another Mediterranean species, *Chalonites abbreviatus*, builds a nest of fine mortar, containing several cells, on the stalk of a plant.

The communities of the social wasps include, besides perfect females and males, sterile females called workers, armed with very poisonous stings and doomed to hard labor for life. The least advanced of the social wasps are called monogamous, because each nest is founded by one female.

The colony of the *Belenogaster*, of South Africa, consists of one laying female and not more than ten workers. The nest, made of paper, like those of most social wasps, contains a single comb, of 300 cells or less, borne obliquely on a peduncle. The female constructs a few rudimentary cells, deposits an egg in each, and enlarges the cells in proportion to the growth of the larvæ, which she feeds with pellets of minced caterpillar meat. The full-grown larvæ spin their own cocoons, but after pupation the mother aids the young workers to escape from their silken prisons, and thenceforth they assist her in caring for her younger offspring. The perfect females and males do not appear until late in the season. After the wedding flight, the young females usually go away and found independent nests, but sometimes they remain with their mother. An approximation to the polygarnous system has been observed in the association of several females born in the same nest.

Our common European wasps are monogamous, but more advanced than the *Belenogasters*. *Polistes gallicus* nests in crevices in rocks and walls. The nest is composed of a single comb carried on a stalk, but it may contain 500 cells and more than 100 workers.

A far higher stage of social evolution has been attained by *Vespa germanica*, the commonest of all wasps, whose range extends from Norway to Algeria and from North America to India. In spring, a female that has passed the winter in some sheltered retreat, begins the construction of the nest. Usually she selects a ready-formed hole in the ground, enlarges it if necessary, and builds the first cells. The combs of all social wasps are suspended by their stalks, so that the mouths of the cells face downward. The founder of the colony exhibits remarkable activity in making paper, forming the first comb of cells, laying eggs and supervising their hatching, feeding the larvæ and aiding them in their metamorphosis. All of this she does without assistance, until the first larvæ have attained the perfect worker state. The mother then gradually restricts her activities to laying, intrusting the care of the nest and the young, and all other work, to her continually increasing staff of assistants. The workers construct additional combs, connected by strong girders of paper. A single nest may contain 12 combs and 20,000 cells.

Vespa germanica improves upon *Polistes* by covering the comb with several layers of paper, thicker than the material of the cells and overlapping like shingles. An interval of about ⅜ inch is left, between the combs and between them and the wall of the nest, for the circulation of the workers. In midsummer, when the colony has become populous, the workers construct a comb of larger cells for rearing perfect females and males. In autumn, a few females succeed in finding shelters in which they pass the winter in a state of torpor. The other females, the males and the workers, die of cold and hunger, and the recently populous nest becomes an abandoned ruin.

Vespa media, common in central and southern Europe, attaches its nest to a tree trunk or branch, and covers it with several layers of paper. The exterior layer, which is the only covering of the lower part, is a smooth continuous sack of very tough, glossy paper, and presents the appearance of a gourd.

The name polygamous is applied to the species in which each nest is founded by several females. This method constitutes an important social progress, for the welfare of the colony is not dependent on the life of a single individual. The existence of a monogamous colony is seriously imperilled, if not actually terminated, by the death of the mother before the metamorphosis of the first larvæ.

The polygamous nest is very large and its life is of unlimited duration. About 100 species of polygamous wasps, all exotic, are known. They very greatly in their skill and development in nest building. Some do little better than *Belenogaster* or *Polistes*, while others construct several combs, but leave them uncovered. We shall select more advanced species for illustration.

Protopolybia emortualis, of Central America, constructs a single comb, attached by several little pillars to a leaf. The builders always select a branch on which other leaves are occupied by nests of an ant of the genus *Dolichoderus*. The comb is covered by an envelope which closely imitates the ant's nest. M. Ducke once found a wasps' nest and an ants' nest on the same leaf. The wasps, though armed with stings, retreated in alarm to the interior of their nest, while the ants valiantly defended both nests.

Leipomeles lamellaria, a native of South American forests, covers its nest with a roof that exactly imitates the veining of the leaf on which it is built, and coats the leaf stalk with a sticky varnish that arrests the approach of insects.

The species of *Polybia*, natives of tropical America, represent the highest stage of social evolution in wasps. Their nests contain many combs, which are supported by the wall of the nest, to which their edges are attached, and which communicate with each other through central openings, forming a shaft. New combs of the same size are added as the colony grows, so that the nest increases in length only. The details of form and material, however, vary greatly in the 30 known species. *Polybia rejecta* exhibits a curious instinct by varying the form of its nest in imitation of the nests of other creatures. In the vicinity of the long pendant nests of the cacique bird, the wasps' nest assumes a similar form, and sometimes attains a length of 5 feet, while it takes a globular form when surrounded by the spherical nests of some ants.

These few examples must suffice to illustrate the progress of social evolution in wasps, which appears to be accompanied by a corresponding development in anatomical and morphological characters.

Fresh Air in Schoolrooms

Cloth Window Screens That Let in Plenty of Filtered Air Without Drafts

By John B. Todd, M. D.

THE work that has been done in the prevention and treatment of tuberculosis has drawn wide-spread attention to the need of fresh air in all indoor places and has caused an inquiry into the efficiency of conventional systems of ventilation in our schools. That our schools are not properly ventilated is now admitted by all who have investigated their actual condition. They are generally overheated without the proper amount of moisture in the air, and here the well known schoolroom odor is especially noticeable in the halls and coat rooms. This well known odor is due to bad breath and body eminations. The odors of the body are definitely recognized by skilful physicians as an aid in determining pathological conditions. "There is no odor," says Thoreau, "so bad as that which arises from goodness tainted. It is human, it is divine, carrion." The Scotch Education Department[1] says of it: "The close smell so familiar is due partly to the subtle organic impurities of the air breathed out by children, partly by the decomposition of organic dirt on the children's bodies or in the room. Such decomposition is usually caused by microbes." This dry, overheated, dust-ladened air robs the respiratory passages of moisture.

During the act of respiration, the dust and bacteria are filtered out in the air passages, at the same time the air passages have furnished water to saturate the expired air. The function of the lymphatic glands of the respiratory passages is to intercept and destroy the inspired bacteria, thus forming one of the defenses of the body against infection. But when the air is dry, overheated, and at the same time over ladened with dust and bacteria, this defense of the body is overtaxed and infection does occur, as is evident by the large number of enlarged tonsils and adenoids which are reported by the medical examiners of our schools, also by the cases of cervical adenitis and tuberculosis that become candidates for the open air schools. The teachers suffer as well as their pupils. The Michigan Department of Health reports that of the deaths occurring among teachers between the ages of 25 and 34, 52 per cent were due to tuberculosis. Scarlet fever and measles always increase during the shut-in months of the year. An editorial in the *New York Medical Journal* of September 6, 1913, states: "In tropical countries where the people divide their time between the open air, and houses so constructed that the outside air has at all times the most complete access to all parts of them, these diseases are practically unknown."

The working of the law of the survival of the fittest is universal, and is as potent in the schoolroom as in the factory. In unsanitary schoolrooms, the weaklings drop out, and become objects of extra care and expense to the public, and help to fill our institutions. Every case of adenoids and enlarged tonsils is evidence of breathing bad air. First the overworked defenses of the body becomes weakened, then the child becomes anemic, when fection occurs. But what effect does an unsanitary school have upon the robust. The overheated, dry, dust-laden air soon produces mental fatigue, and as a result there is retardation in mental growth. They cannot do their best work without an abundance of fresh air. They lack interest, become restless, it becomes harder to maintain discipline, all of which shows that they are not doing their best. All this is evident as occurring at the present time, but we should also consider the remote effect of retarded physical and mental growth upon the life history of the individual as extending to a greater or lesser degree through the life of the individual, and more remotely to unborn generations.

We will not discuss the theories of ventilation. The question of how bad, bad air has to be, to be really bad, is a long road in the literature of the subject. It is the conclusion of some eminent authorities, that it is not bad at all, but that which we think is its bad effect, is merely a disarrangement of the heat regulating apparatus in our bodies, in other words high humidity and temperature, although in schoolrooms the bad air is of high temperature and low humidity, and at the same time it produces troubles which we seek to avoid. Although the laboratory experiments of these eminent authorities all seem to demonstrate that bad air is not bad, still they all practically agree that clean, out-door air is best, and that the physiological test is the only one for last resort. Hoobler[2] states: "The most favorable conditions for maintaining blood pressure at normal are those present in the open air. To obtain such results indoors, such methods of ventilation should be employed as to approximate the conditions out of doors." Hough[3] says that "After all, the final test is the experience of the occupants of the room." Prof. Wislow[4] states: "Extended study of actual conditions in relation to their effect upon physical and mental efficiency can alone furnish a sound basis for such standards as we should like to possess."

The lack of ventilation in schools is largely due to the design of the buildings. All the forms of architecture have been utilized in their construction, and the result is generally beauty of form externally, but they are inefficient in maintaining the health of the growing child. One may copy the external form of Parthenon, but one should remember that the Academy, the most famous school of all times, had the vault of heaven for a covering and the four points of the compass for its side walls.

The interior design of our schoolrooms seem to be that of a linear descendant of the monastery—an interior hall, dark and filled with a bad odor, while opening from it are lateral cells or class rooms. The universal use of glass has provided a means to light these cells or classrooms, but no means has been found to keep them full

[1]Ainslee, J. T., Translation, Fifteenth International Congress on Hygiene and Demography.

[2]Hoobler, B. Raymond, Translation, Fifteenth International Congress on Hygiene and Demography.

[3]Hough, Thadeus, *Am. Jour. Pub. Hygience*, vol. 20.

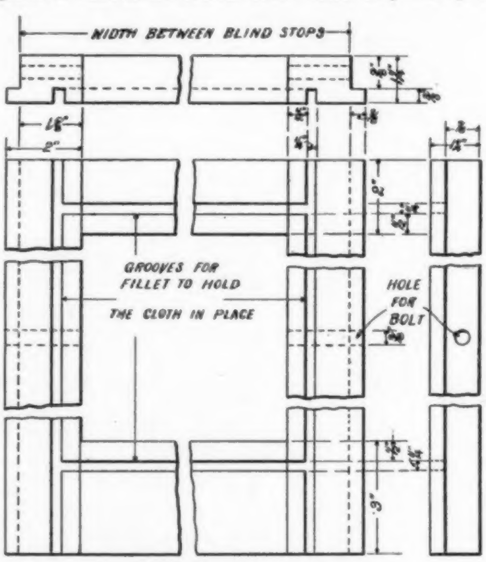
[4]A. E. Winslow, N. A. S. report, 1911.

of fresh, sweet air. Buildings fitted with apparatus that is supposed to be capable of delivering eighteen cubic feet of air per pupil per minute are full of stuffiness, the children are restless, there is hacking and coughing.

In our rigorous northern clime, the first thought is to provide a sufficient protection from the winter cold, the second requirement is to provide a well-lighted room, and we fill the side wall with glass which furnishes the light, but this same side wall of glass prevents proper ventilation because glass is the greatest radiator of heat known, and it chills the bad air so rapidly that sufficient good air cannot be furnished to properly ventilate the rooms, while the halls and coat rooms are filled with stale, dead air and dust. From extended studies of air conditions in schools, I found that the problem was to introduce a sufficient quantity of fresh air into a warm room to make it hygienic and, at the same time, to avoid drafts. Drafts in a room are currents of air with velocity enough to be perceived, and if such air is cold, they are uncomfortable. So the problem was to introduce cold air, but of a very low velocity. If of a very low velocity, there must be a large inlet to get sufficient volume.

The experiment was tried out last year in Summer School in Syracuse. It is a modern 16-room building, with a registration of 750. It is equipped with a fan which forces hot air into the room; there are also steam heated pipes along the outside walls under the windows. During school hours the windows and doors are closed to keep the ventilating system in working order. The rooms are stuffy and close, and the well-known schoolroom odor is present. Many of the pupils suffer from headaches, and sometimes one will faint.

The schoolroom in question had 5 windows facing the east. The lower sash opening was 40 inches by 36 inches. Wooden screens were made and covered with a medium grade of unbleached cotton cloth. After they were put



The Todd Window Screen

in place, the windows were kept open during school hours. The stuffiness and odor entirely disappeared, as did all snuffling and coughing in the pupils. No more cases of fainting occurred, complaints of headaches ceased and the pupils have done better work.

Before school opens in the morning, the janitor closes the windows and warms the room to 70 degrees by hot air from the fan. This is humidified by a steam jet in the mixing room. When school opens, the windows are raised and the hot air inlet closed. The windows were open through all the days of winter, although children sit within five feet of the open window. Only on occasions of very severe wind have windows been lowered, and then only in exposed situations, and even on such occasions, one or more would be raised at intervals. There are no cold draughts, the velocity of the hot air rising from the radiator pipes is greater than that of the cold air which is being slowly diffused through the screens, so that the resulting direction of the air current is upward. February 10th was the coldest day of the year. At 10:00 A. M., it was at zero outside and 70 degrees in this room with every window open—fifty square feet of opening.

The screens furnish fresh air of very low velocity from a large surface (about fifty square feet in this room) with no heat loss from conduction, whereas with the windows closed, we have a large area of glass cooling the bad air—glass transmits twenty times more heat than cotton. The slow diffusion of fresh air does not seem to cool the air in the room any more than it would be cooled by the glass if the windows were down. The janitor says that the room has been warmed as easily as it was before the screens were used. Other teachers were at first incredulous, but as they observed the improvement in work and discipline as a result of the fresh air conditions, they had the windows in their rooms fitted with screens. In that way the idea has spread to other schools. The public has become interested and many pupils at the request of their parents have been transferred from closed to fresh air schoolrooms. A committee of the Associated Women's Clubs investigated the fresh air schoolrooms and they have helped spread the idea. The teachers and pupils have learned the benefit and comfort of fresh air, and the educational value of this experiment has been of much benefit to the community.

Public opinion at the present time is very favorably inclined to fresh air schools and it only needs the action of the school authorities in the matter to effect a reform that will save more than a hundred times its cost, for disease is expensive besides the suffering and misery it entails, and the greater efficiency of the children will be a gain that will be much greater than the cost.

I presented a paper on Fresh Air Schoolrooms to the Fourth International Congress of School Hygiene at Buffalo and in that paper were letters from the teachers giving their unanimous endorsement. Here is one of them. Miss Kinsella of the 5–2 grade writes: "We have enjoyed our open air room very much this term. The air has always been pure and fresh, and the room did not at any time seem close as it often does with closed windows. When we moved during the middle of the term from an open air room to a closed room, both the children and I were greatly disappointed. The Principal said we might take the screens with us, but as it was impossible to have them transferred for a few weeks, the children and teacher who were then in our former room, had enjoyed them so much that they did not want to give them up. The Principal then very kindly had some made for our room and we were happy again. I have found the discipline of the room to be much better since we have had the screens. The children do not get so restless or tired as formerly. During the winter, the children had fewer colds than usual, which I believe due to being in the fresh air all the time. I also found that true in my own case."

In the discussion of my paper, it was suggested that I had hypnotized the teachers. To ascertain if the physical condition of the air in these fresh air schoolrooms would warrant the opinions of the teachers as to the improved conditions, examinations of the air have been made. In this work I have had the advice, assistance, and co-operation of Drs. D. M. Totman, Health Officer, F. M. Meader, City Bacteriologist, Prof. H. C. Ward of the Syracuse University, and Mr. Morgan Sanford of the local station of the U. S. Weather Bureau. These examinations show that the humidity in these fresh air schoolrooms is practically that of the outdoor air, while the dust under normal conditions is very materially reduced, and in some instances practically eliminated, and that the condition of the air warrants the opinions of the teachers. The result of 18 examinations for dust in fresh air schools, under various conditions of weather, and of the same number of examinations of closed window schoolrooms in 5 different schools, shows that the fresh air schoolrooms have 33 per cent less dust.

The dust is eliminated from the fresh air schoolroom in two ways: First, by closing the inlet from the fan. In the plenum system, the normal out-of-door dust is carried into the schoolroom and this is increased in most instances by having the inlet to the fan on a level with the ground. All this dust, which is laden with bacteria, is carried into the schoolrooms and then tends to accumulate, the slower velocity of the air circulating in the room allowing it to settle gradually while only a portion is carried away through the vent. With the fan inlet closed, a large quantity of dust is kept out. Second, the cloth screens in the windows filter out the dust of the incoming air. This is shown very clearly by the discoloration of the screens after having been used for a time, which is better than having the children's lungs used as a filter. Repeated tests of the fresh air schoolrooms for dust, have shown that wherever there is much dust in the air it has occurred when the streets and playgrounds are muddy, and the mud has been brought in on the children's feet.

Another great improvement noticed in the fresh air schoolrooms is that the humidity is practically the same as it is out of doors.

From an economic point of view, the fresh air rooms are satisfactory because experience has shown that they can be warmed as easily as a closed window room. The reason is that the glass cools the bad air by radiating heat out of the room while the cloth screens do not, but instead allow fresh filtered air to diffuse slowly into the room. In warm weather, by closing the vent, opening the inlet air duct and reversing the direction of the fan, the rooms are perfectly ventilated by the screened windows with fresh, filtered, dust-free air.

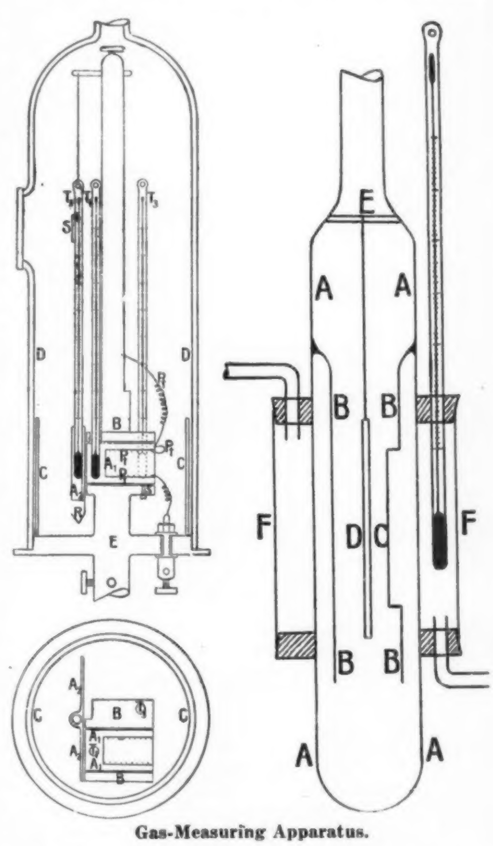
The cloth screens do not interfere with the lighting of the room unless they are allowed to become discolored with dust, the light rays are broken up and diffused throughout the room so that the character of the lighting is really improved. There is no novelty in the use of screens in windows. Probably before the use of window glass became general, our ancestors used cloth screens in cold weather. Billings in 1893 described inlet opening covered with wire gauze or else the use of cloth or a thi layer of cotton.

The novelty of my experiment was not merely i putting in a cloth screen in a window, but in putting i *fifty square feet of screens in one room* and in maintainin a temperature of from 68 to 70 degrees, and a humidit equal to that of outdoor air, at the same time excludin a large amount of dust that would have been driven i by the fan by leaving the air inlet from the fan closed an filtering the dust from the air that came through th screens. It is evident that with outdoor conditions o temperature and humidity, together with filtered air made possible by the use of fresh air screens, the nex great step is to prevent dirt and dust from being brough into the room by the children. This can be accomplishe by having dustless playgrounds and by insisting on clea shoes as well as clean faces and hands.

A Remarkably Fine Gas-Measuring Apparatu

Dr. Knuden, of the University of the charming cit which we take the liberty of calling Copenhagen, althoug its proper name is Kjobenhavn, describes in the *Annale der Physik* a new measuring apparatus of very grea delicacy. It consists of an absolute manometer fo measuring gas pressure, where a delicacy is require that corresponds to only 1/1,000 of a millimeter o mercury column.

In looking at an ordinary barometer, one can readil

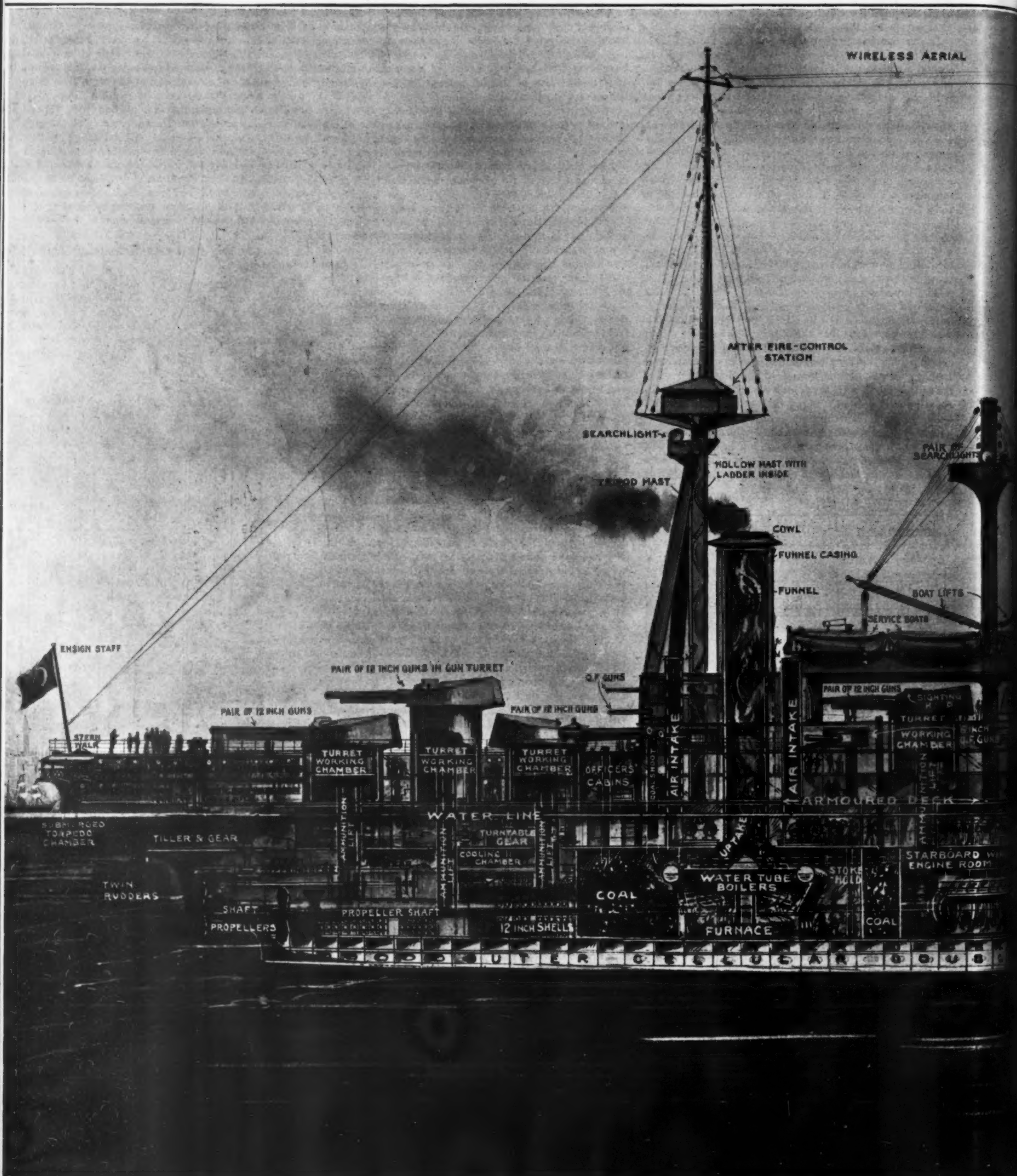


Gas-Measuring Apparatus.

see that noting a difference of height of the mercury column of only half a millimeter (1/51 inch) woul require more than usually sharp eyes or instruments even if the barometer were capable of showing it wit such help. But when it comes to only a thousandt of a millimeter (1/25,400 inch) that seems beyond th range of possibility.

The new instrument is based on the measuring o the pressure between two plates of different temperature, surrounded by the gas, the pressure of which is to be measured. The distance between these plates must naturally be very small. For the pressure Dr. Knuden has found an absolute law. The apparatu consists of a polished copper plate, hung on a thin platinum wire, so that its sides are vertical. Opposit one of the sides of this plate there is an immovable copper cylinder, that end of which, lying next the copper plate, being highly polished. The temperature of this cylinder may be raised by an electric current passing through a platinum coil surrounding it. The expansion of the cylinder moves the plate, by an amount which is read off from the reflection cast by the mirror.

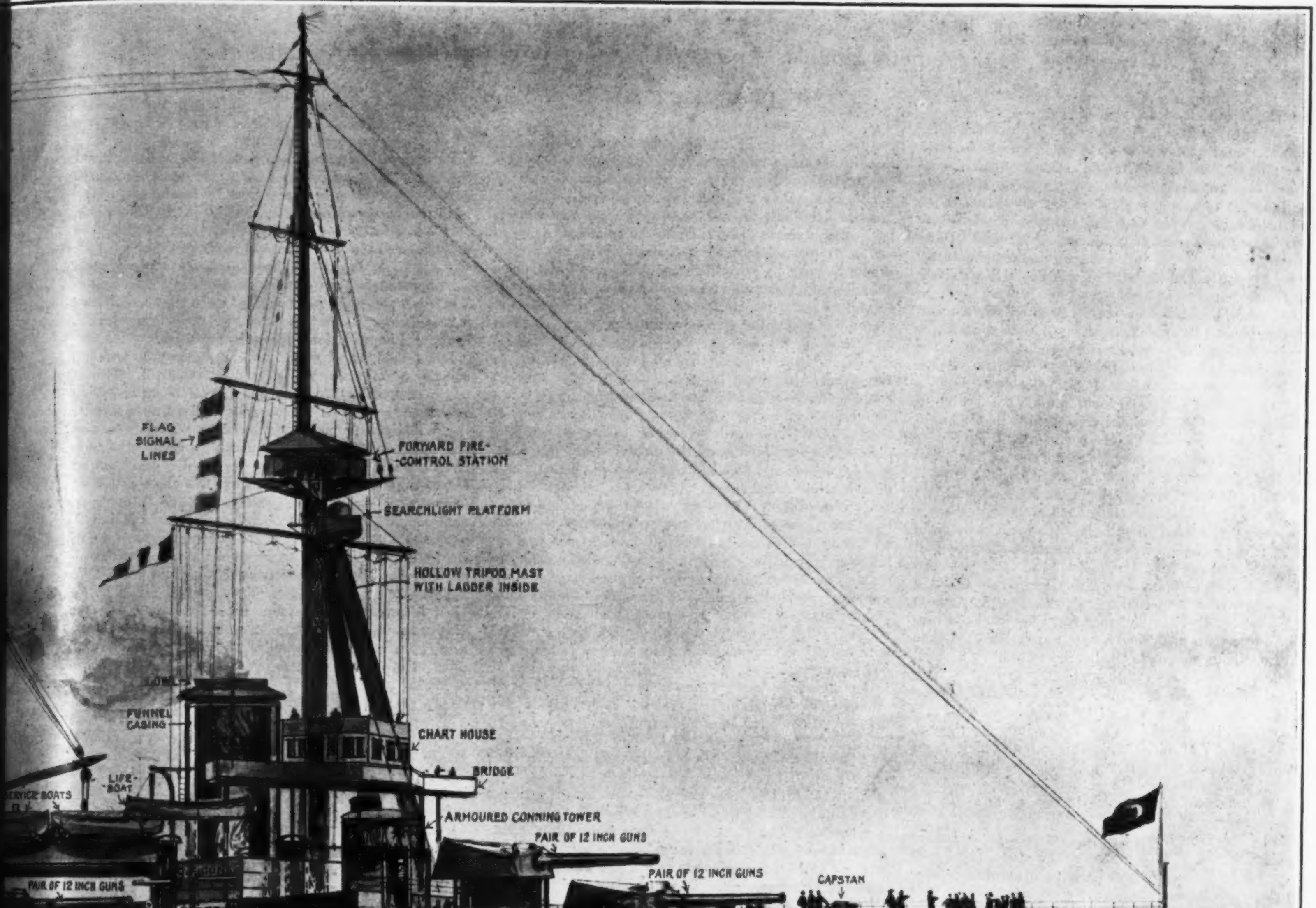
Seven Loops in a Biplane.—Turning seven somersaults in a biplane in one flight on Januray 4th, Lincoln Beachey established a new aviation record. One of the loops was executed directly above a crowd of more than 20,000 persons. In another loop Beachey did what is known as the "corkscrew" twist while his aeroplane was in a perpendicular position.



By courtesy of the *Illustrated London News.*

THE "RIO DE JANEIRO" NOW OW

The startling announcement was made recently that Turkey, to the chagrin, particularly, of Greece, Italy and France, had bought the Brazilian battleship "Rio de Janeiro," which was launched from the Elswick Yard of Sir W. G. Armstrong, Whitworth & Co. on January 22nd of last year, and is now being completed. There were then those who feared that this transfer of a Dreadnought, superior to the only powerful ship of the Greek navy, presaged the imminence of another Balkan war; for, with her, the Turks believe that they could recover from Greece by force of arms the eleven Ægean Islands they lost in the struggle of 1912–13. The Greek counter-stroke was not long in coming; for, if report from Vienna be true, Greece is to buy the Dreadnought "Almirante Latorre," which is being built for Chili by Messrs. Armstrong and Whitworth, and was launched in December last. Meantime the Turkish Committee for the Development of the Navy has invited the public to contribute toward the payment of "this debt of patriotism and honor;" and it has been officially announced ... builders of ... would con... purpose of ... Government ... is a speed



NEIRO" W OWNED BY TURKEY

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nounced from Rio de Janeiro that the Brazilian Government laid a scheme before the ilders of the Brazilian battleship which has been sold to Turkey, proposing that the firm hould construct another Dreadnought without any loss to the Brazilian Treasury, and rpose of the "Rio de Janeiro" without any intervention on the part of the Brazilian overnment. The "Rio de Janeiro" is a Dreadnought of 27,500 tons displacement, and s a speed of 22 knots. She is 632 feet long. Her armament consists of fourteen 12-inch and twenty 6-inch guns. When she purchased the vessel, Turkey also bought about $1,250,000 worth of ammunition. The "Almirante Latorre" is a Dreadnought of 28,000 tons displacement, and has a speed of 23 knots. Her length, between perpendiculars, is 625 feet. Her armament consists of ten 14-inch B.L. guns, sixteen 6-inch B.L. guns, four 3-inch, two 76-millimeter 12-pounder boat-guns, four Maxims, and four 21-inch submerged torpedo-tubes.

Efficiency and the New Tariff*

How Scientific Management Enables America to Compete with Cheap European Labor

By Harrington Emerson

UNDER existing conditions the abolition of the tariff may and will let in the foreign product. Under conditions our American intelligence can bring about, we can laugh at foreign competition, but we cannot laugh and persist in our old and inefficient ways. I believe Americans to be capable of higher efficiency than any other people on earth. I also know them to be actually astonishingly inefficient, and in this actual inefficiency lies the danger.

The proof of our ability to excel in international competition is seen in our battleships. A battleship is the one institution that is universally standardized. At the coronation of King George, the U. S. S. "Delaware" was the largest dreadnought present and this rather humiliated the British. The efficiency of our battleships in battle practice is 3,000 times greater than in 1898, and is the highest organized human efficiency I have ever seen. The American navy does not waste time and money spying on other navies to learn their secrets; it spends its time and money keeping in the lead, and you can't do both at the same time.

I admired the splendid optimism of an American grain exporter who proudly showed a Hungarian delegation all our grain methods from the vast field of Dakota to the holds of export steamers. When asked why he was giving away these secrets to competing foreigners, he replied: "They can't remember half they see; they can't put into effect more than half they remember; and by the time they do, all our present methods will be obsolete; we shall still be ten years ahead of them."

The cringing fear that changes in tariff will permanently cripple us, robs us of the courage to recapture through efficiency what we are losing in protection, to pit aggressive and initiating intelligence and high wages against routine and low wages. Therefore, even though tariff changes hurt, let us laugh and not cry, even as we had better laugh at many other influences we would like to have different, the weather for instance.

There are two great policies open to every man, exemplified in the lives of oysters and clams. The oyster stays put and does the best he can with circumstances; the clam moves about and selects circumstances to suit his needs. The difference is an interesting zoological distinction, and it also causes a fundamental legal distinction. The oyster is a domestic animal that can be recovered if drifted away by a current, but the clam is a wild animal and cannot be recovered if he chooses to stray. Great Britain without tariff achieved prominent rank as a manufacturing nation, importing raw materials, while America and Germany have become great manufacturing nations behind high protective tariff walls. In the northern regions wild and tame animals thicken their fur in winter and thin it in summer. They have learned to play the climatic game. The largest mammals in existence, the whales, inhabit the coldest regions on our planet. The largest land mammal is the elephant, but the mammoth lived in great numbers in extreme northern Siberia. All this shows that a nice beneficent tropical climate is not necessary for vigorous life.

While I would not advise making bananas the main crop of North Dakota, the climate on the whole being better suited to wheat, I have no doubt Luther Burbank could grow in North Dakota bananas of so delicious and exceptional a flavor that millionaires all over the world would send for them. I have seen beautiful apples clipped at the tree and sealed in paper bags, labeled with the information they had never been touched by polluting human hands, sell for 40 cents each at New York hotels. There was no duty protecting those apples from the pauper competition of the fly stung, worm eaten, scale-blasted apples of many shiftless eastern orchards. A certain alarm clock sells in great numbers, 3,600 a day, over the whole country for $2.50. Other alarm clocks guaranteed to wake the soundest sleeper, can be bought for 50 cents. It is not a tariff duty that protects the $2.50 alarm clock from the competition of its less insistent rivals. The 50 cent alarm clock will suffer from tariff competition, but not the $2.50 alarm clock. It is not apples or clocks or inclement climate or abundance of natural resources that in last analysis count, it is the men, the human character and intelligence behind the apple and the clock, behind our other great American industries, that count.

What is the theory of the protective tariff? It is that Americans cannot compete with foreigners. As America has the greatest and cheapest natural resources in the world, the contention becomes that the American worker cannot compete with the pauperized labor of older civilizations. Other qualities, honesty, industry, frugality, intelligence and wages per day being equal, it is true that the man who works twelve hours per day accomplishes more per day than the man who works eight. It is also true that the long houred labor of children and women is cheaper than the short houred labor of men. In so far as Americans consider it desirable that the worker should be not only a working machine, but also the competent head of a family and a good citizen, therefore that he should not work all his waking hours, there is good reason for extending governmental protection to ideal standards of life. In fact, while it has not yet realized it, the chief modern function of government is not to carry on wars, either of conquest or defense, but to supplement the citizen in those matters which are beyond individual and corporate control. The government is there, not to tone down conditions to the level of the diseased, the unintelligent, the dishonest and the lazy, but to protect the strong from epidemics, from waves of mental and moral anarchy and from financial panics.

If protection for long established industries, doing everything possible for themselves, is needed, it should be extended until conditions can be re-adjusted, but no industry is entitled to protection that is not intelligently making the best of the situation—and very few American industries are in this class. A basis for comparison is standard wages per day and a standard equivalent in result for the day's wages, i. e., no man may normally earn less than the standard amount, but nevertheless have opportunity to earn more, either by faster speed in less hours, or longer hours at less speed, or both, as among the locomotive engineers, who also normally give an agreed upon equivalent in standard work for standard pay.

What other elements besides wages per unit of output enter into all costs, whether American or foreign? A plant in the Middle West was, and still is, manufacturing certain automobile parts. In spite of a 40 per cent duty, it constantly had to meet the competition of German importations. In this particular plant direct labor cost was far more than material cost, a few cents worth of material being converted into dimes worth of product. Under these conditions it seemed as if tariff protection was essential, but as it also seemed extremely likely to the president of the corporation that the tariff would be removed, he made up his mind he would continue to manufacture and to compete. He made a complete efficiency survey of his plant and all the conditions affecting manufacture, he improved what could be improved, and without cut of wages he is now in the game to stay. He found that there are many conditions besides wages that affect cost. By ameliorating these, he was able to overcome the foreigners' advantage in wage rate. Those various conditions, including wages, have by efficiency engineers been classified under eight heads.

VOLUME OF BUSINESS.

The United States manufacturer has nearly 100,000,000 well-to-do, fairly homogeneous, inhabitants as his customers. What a tremendous advantage this gives our publishers, for instance, whether of dailies, of weeklies, of monthlies, or of books, over Danish, Swedish, Dutch, Portuguese, or Italian publishers with their limited reading public! The subway in New York is the most expensive railroad in the world per mile to build and operate, yet so great is the volume of its business that it carries its passengers farther for less money per mile than any other railroad in existence. In 1896, the United States manufactured a million bicycles, and exported some of them to Japan, one of the cheapest labor countries in the world. The vast quantity made reduced the export price to $12.00.

The dollar watch is an American development. There are about 50,000,000 people to whom such watches could be sold, and 32,000,000 have been sold. An American automobile manufacturer is making this year 300,000 automobiles which he sells at a price one tenth of what much poorer imported automobiles cost ten years ago. In a large American bolt and nut plant, we checked up the difference in cost per bolt of filling an order for 100 bolts and filling an order for 10,000 of the same bolts. The 100 bolts cost 38 times as much per bolt. No carrying trade in the world is as cheap as that on the Great Lakes between upper Lake Superior and lower Lake Erie; coal in one direction, iron ore in the other. No railroads in the world carry as cheaply as some of the American coal and ore roads. Both as to lake steamers and railroads, volume of traffic is the explanation. The American manufacturer as a whole, therefore, has a very great advantage over his foreign competitors on account of volume of product.

SUPPLIES.

It used to be expensive to live at Helena, Mont., on the upper Missouri, or at Circle City, on the Yukon. Supplies came in only once a year by steamboat on the June rise of the rivers. Men had to invest in a whole year's outfit at once. The supplies, once bought, were subject to deterioration and shrinkage. Any concern that has to lay in excessive supplies of material, of labor, of equipment, is under a great disadvantage. The United States is wonderfully well situated as to supplies. There is no occasion to carry large stocks. This lessens taxes, insurance, depreciation and interest charges.

It is terribly expensive to have on the payroll ten men because occasionally you may need them all. This is one of the reasons why steamers have replaced sailing vessels on the ocean. The steamer carries a normal crew, the sailing vessel must carry a crew large enough for any emergency. Most American plants are over-equipped, machines not busy more than one third of the time, or else running at one third efficiency all of the time. This unnecessary cause of high cost is not due to our high standards of living but to our low standards of intelligence. It is well known that German farms, in spite of the far northern and unfavorable climate, poor soil, produce per acre twice as much as our American lands. We are over-supplied with land. The Germans utilize better what they have. We have a natural advantage in our ability to run close on supplies, we have frittered it away by investing in over-supplies of both equipment and men. Here is a chance to effect economies without re-adjusting wages.

RATIONAL USE OF MATERIALS, LABOR AND EQUIPMENT.

The man who cuts a 16-inch log into a 7 by 10 railroad tie wastes material. The man who takes a long and slow stroke, a shallow feed and depth of cut so that his work takes 80 times as long as necessary, is wasting man time and machine time, and adding unnecessarily to cost. The efficiency of use of materials, men and equipment in many American manufacturing plants is not over an average of 80 per cent. In more efficient use there is very great opportunity to lower costs.

PRICE OF MATERIALS, MEN AND EQUIPMENT.

We are great producers of raw materials. They are lower in cost than elsewhere in the world. This is in our favor. Equipment does not usually cost more here than elsewhere; our machine tools are exported all over the world. Our wages are higher! In those lines of small items of manufacture in which labor and equipment are the chief cost, as watches, bicycles, sewing machines, Americans have been able to compete with the world. In those big pieces of manufacture in which raw materials, iron, wood, etc., are the chief items of cost, as harvesting and other agricultural implements, American plants, even a thousand miles inland, manufacture so efficiently and cheaply that they can and do export to all the world in competition with every foreign manufacturing country. Intelligence, low priced materials and super-excellent equipment rather than price of labor seem to govern both for the little and the big.

ASSIGNMENT FOR PRICE.

It is not always so much what is paid for materials, men and equipment, that counts as the rational utilization of their qualities. There is great waste if we use high priced materials, men and equipment for low grade work. It does not pay to use silver when copper will answer; it does not pay to use four horses if one pony can pull the load; it does not pay to use the time of a skilled, high-priced man on work that could be done by an unskilled low-priced man. These are all instances of improper assignment for price. In wrong assignment for price there are many wastes, especially in tariff protected industries.

ASSIGNMENT FOR QUALITY.

This is the reverse of assignment for price. As to materials, men and equipment, it does not pay to use iron wire instead of copper, for electrical work; it does not pay to use carbon steel instead of high speed steel; it does not pay to load down a man with responsibilities above his ability; it does not pay to use a sewing needle instead of a sewing machine for continuous work. It is an important and much neglected law that values of materials, of equipment, and of men, increase faster than their market cost. Carbon steel costs 14 cents a pound. High speed steel from 50 cents to $5 a pound, but it would be comparatively cheap at $500 a pound.

As to many lines of work the more expensive the equipment, the cheaper the cost of the product. Railroads carry more cheaply than Chinese coolies; steamers carry cheaper than sailing vessels; charred sticks and shells dig more cheaply than bare hands; spades dig at less

*Reprinted from the *New York Evening Post*.

cost than shells; steam shovels are, if the work is big enough, more economical than laborers using spades. Would the Panama Canal have been possible without steam dredges? America has led the world in the matter of labor-saving machinery, which in many cases wholly neutralizes higher wages.

Although a great Japanese genius, Hideyoshi, who lived in the sixteenth century, was the first executive to abolish overtime and institute planning, the first to make time and cost studies, and to institute dispatching—nevertheless, in Japanese coal mines, the output per year is under 100 tons of coal per worker on payroll. In the best American mines it is over 1,000 tons of coal per worker. European countries occupy intermediate positions between Japan and the United States. The German and the French averages are about 400 tons, the English average under 600. What matters it that the Japanese rate of pay is only one tenth the American rate? The wage cost per unit is as low in America as in Japan, the overhead charges per unit are lower. On the other hand, American costs have in many instances been added to by over-equipment, one of our great national faults.

A railroad is not so economical as a mule team, if only one short train a day runs over it. A big flanging press is not as cheap as a hand flanging, if the press is only used one day a week; a 112-inch paper machine is not as economical as a 56-inch machine if the former breaks down three times as often. A big hotel is not as economical as a boarding house if the guests fill it only three months in the year. A 100,000 pounds capacity freight car is not as economical as a 40,000 pounds car if the average load is only 20,000 pounds. With the faults of our virtues, we have not only resorted to elaborate and labor-saving equipment, beating the world in this respect, but we have overdone it, neutralizing part of our advantage by over-equipping.

SALES QUALITY OF OUTPUT.

In this respect, America is still far behind manufacturing Europe and Asia. We take a pine-log and convert it into a railroad tie, the Swiss take a similar log and convert it into a wood-carving worth its weight in silver. We export cotton at 10 cents to 16 cents a pound, and it comes back to us in the form of lace at $10 a pound. Most of our exports are raw or semi-manufactured products. Most of our imports are highly manufactured products. We are exporting our irreplaceable natural resources, exploited by gigantic machines guided by elementary and unskilled labor, and we are importing these same materials after they have increased in value many fold through human brains, human skill, human industry. Foreigners—English, German, French, Hungarian, and others—have come over here and under our American noses have built up skilled manufactories of all kinds.

I remember when Montana silver ore was carried 400 miles by teamsters, freighted by train to San Francisco, shipped by sailing vessel to Hamburg, freighted to Freiberg in Saxony, reduced to bullion, and draft for balance to Montana. We Americans were so busy digging gold and silver, we had no time nor brains left to learn how to treat the ores, so our American smelters were developed by a German immigrant whose numerous sons are to-day the heads of the greatest smelting plants in America.

Cotton cloth sells for 18 cents a pound, the raw cotton costing 10 cents to 16 cents and the big cotton mills are almost bankrupt. Ramie sells for 10 cents a pound, the woven product brings $1.00 a pound, and the foreign owners of the little American plants are rapidly becoming wealthy. American silk in plain color sells for 40 cents a yard, French silk of the same quality and weight but of beautiful pattern sells for $1.00 a yard. We sell material and labor, the Frenchman adds brains. The nation without raw materials, the Swiss, export millions annually of Swiss intelligence which they have added to the crude products.

SALES PRICE.

Alarm clocks can be purchased for 50 cents each. How does it happen that one firm can sell its clocks for $2.50 each? Granulated sugar, chemically pure, is worth about 5 cents a pound. How does it happen that one firm can make millions selling chemically pure the same sugar for 10 cents a pound? A Scotch firm making circulating pumps used to obtain three prices for them because it made them and delivered them in 24 hours. Sales price is one of the oldest and also one of the most neglected of arts. All values except those we share with the beasts of the field are products of the imagination, and the purchaser will pay what you ask him, provided you have inflamed his imagination. The best of food can often be had for the lowest price, the poorest of food may command the highest price. What is the difference in nutriment between candy at $1.25 a pound and sugar at 5 cents? The sugar is chemically pure, the candy is not! These illustrations of the various principles that affect costs and prices show that the price of labor may in many cases, be wholly without relative importance.

Some men are born efficient, others achieve efficiency, and others who have hitherto relied on tariff protection must have efficiency thrust upon them—or go under.

It is not a subject to be dismissed flippantly. Some industries cannot stand the sudden change, the time being too short in which to make the new adjustments. For others it will be easy. But between the two extremes are a great number of industries for whom the stormy and difficult path of efficiency is the only way of escape.

An Opiate Derived from Lettuce Juice

The lettuce plant has had a reputation as a sedative from very ancient times. The Romans were in the habit of partaking of it at the evening meal to insure peaceful slumbers. In later days many celebrated physicians prescribed it as a soothing herb, but it was not until the end of the seventeenth century that Dr. Cox, of Philadelphia, experimented extensively with the *latex*, or milky juice obtained by making incisions in the stem. This crude juice, when dried into a solid mass, he named *lactucarium*, and he, as well as other doctors, in Edinburgh and Paris, proclaimed its virtues as a substitute for opium.

The name lactucarium is now applied to the active principle of the juice. For this to be of practical service it was necessary to discover means of producing it in sufficient quantity to meet the demands of pharmacists and of preparing it so that it would possess a reasonable "constant" of activity.

These problems were solved about the middle of the last century by a French savant, Hector Aubergier, of the scientific faculty of Clermont, who devoted ten years of experimental effort to creating the industry of *lactucarium*.

The present condition and the value of this industry are described at some length in a late number of *Larousse Mensuel*.

The best known species of lettuce, it seems, is the common cultivated *Lactuca sativa*, of Asiatic origin, which has been a standby of the market gardener for centuries. Among seven or eight species indigenous to France the most important are *L. perennis* and *L. virosa*.

"The first, which inhabits dry coasts, is a smooth and spineless herb, reaching a height of fifty centimeters at most, with blossoms of a violet-blue color. The second, which is much more widespread in growth, is a large biennial herb, growing in rocky and uncultivated situations. It attains a height of two meters (over six feet); its flowers are yellow; the base of the stalk is covered with numerous thorns or spines; its stiff leaves, armed with short, spiny teeth, have the curious peculiarity of protecting themselves against the ardor of the sun's rays by presenting their edge to them.

"At mid-day they orient themselves toward the source of light so as to be placed in a vertical plane which corresponds to the meridian of the locality. For this reason the poison lettuce has very justly received the appellation of the *compass plant*.

"The leaves of this poison lettuce have a toxic quality. Boe, cited by Lanessan in his *Flore Médicale*, has published in the *Bulletin therapeutique* an observation of the poisoning (non-fatal) of three persons by the fresh leaves of this plant. The cases were marked by delirium, hallucinations and severe pain, and entire relief was obtained only at the end of 24 hours."

Prof. Aubergier experimented with varieties of lettuce from all over the world, finally fixing his choice on the giant lettuce (*L. altissima*) both because of the quantity of juice furnished and its richness in active principles.

"The giant lettuce, a native of the Caucasus, is a biennial herb, regarded by many botanists as a mere variety of the poison lettuce. Its smooth, straight stalk reaches a height of two or even three meters or more (6 to 10 feet). It is green, cylindrical and branching only at the top. The leaves are non-petiolate, provided with auricula at the base; they have a strong middle rib and are dentate and covered with soft spines. The inflorescence is a very branching panicle, with large yellow heads; the fruits are black akenes."

The seed is started early and transplanted outdoors in the spring as soon as the weather permits, the plants being placed 50 centimeters apart (about 20 inches). They are carefully cultivated and in June the stalk begins to ascend and makes ready to flower, and the *latex* becomes abundant. The lactiferous vessels are contained in the superficial layers of the bark, and when this is cut the milk promptly oozes out in white drops. In July and August the plants are ready for the "bleeders," who are almost hidden among the giant stalks.

"Each plant is bled two or three times at intervals of about fifteen days. The first cut is made at a height of about 20 centimeters from the ground (about 8 inches) on only one side of the stem. The second cut is above the first on the opposite side, and the third is still higher. The incisions are made obliquely with a knife having a short, almost triangular blade; the *latex* is collected in a glass receiver. A skilled workwoman can collect a kilogramme of *latex* per day, but the average is about 600 grammes.

"When the bleeding is at an end the plants are left to ripen their seeds; after these have been gathered the stalks are used for fuel. The plant is not cultivated twice successively on the same land.

"The fresh *latex* has the aspect and consistency of cream. It reddens litmus paper and rapidly blackens the blades of the cutting knives. Exposed to the air it turns a bright yellow, then gradually turns brown, losing more than two thirds of its weight in water and forming a solid mass whose surface is often covered with a crystalline efflorescence of *mannite*.

"The crude *lactucarium* has a characteristic odor—strong, disagreeable and poisonous—and an extremely bitter taste. It is handled commercially in round, flat cakes weighing 10 to 30 grammes.

"The pure product is obtained by pulverizing the crude lactucarium and macerating it for several days in four times its weight of pure alcohol at 56 degrees. It is then filtered and the residue submitted to the same treatment. The two alcoholic solutions are mixed and then distilled at reduced pressure to recover the alcohol; finally, it is concentrated to the consistency of the dry extract. The yearly product amounts to from 1,500 to 2,000 kilogrammes, of which most comes from France and Germany in about equal shares. . . .

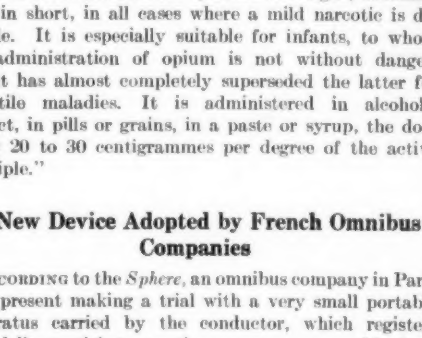
"Lactucarium is a very complex substance. By chemical analysis the following components have been separated: *lactucone*, $C_{14}H_{24}O$, an odorless, tasteless, crystalline, neutral body, insoluble in water, but soluble in ether; *lactucic acid*, which is crystallizable and of a brilliant yellow color; also gum, sugar, albumen, asparagin, a resin composed of *cerine* and *myricine*, acid oxalate, malate and nitrate of potassium and various other salts.

"The current use of this substance in medicine for half a century has proved indisputably its sedative and quieting properties similar to those of opium, but very much milder. It has not the disadvantages of the *latex* obtained from the poppy; it does not provoke obstinate constipation, cerebral congestion, nor loss of appetite.

"It is recommended for convulsive coughs, insomnia and, in short, in all cases where a mild narcotic is desirable. It is especially suitable for infants, to whom the administration of opium is not without danger, and it has almost completely superseded the latter for infantile maladies. It is administered in alcoholic extract, in pills or grains, in a paste or syrup, the dose being 20 to 30 centigrammes per degree of the active principle."

A New Device Adopted by French Omnibus Companies

According to the *Sphere*, an omnibus company in Paris is at present making a trial with a very small portable apparatus carried by the conductor, which registers and delivers tickets as the passenger pays his fare. "The apparatus stamps the various first and second class tickets for the single sections of the whole distance.



A New Automatic Ticket Distributer.

The tickets bear other indications, including the route on which the ticket is used, the section at which the passenger entered the omnibus, the hour and the minute, the date, the number of the ticket, and the number of the apparatus which delivered the ticket. Counters give the exact number and total price of the tickets delivered for the whole day. The construction of the apparatus is extremely simple and its functions can be learned by the conductors in a few minutes. The great advantages of this system over the present one will probably lead to its adoption by all the omnibus companies in Paris."

The Experimental Laboratory of the Automobile Club of France

Testing Internal Combustion Engines for the Automobile, the Flying Machine and the Farm

By Jacques Boyer

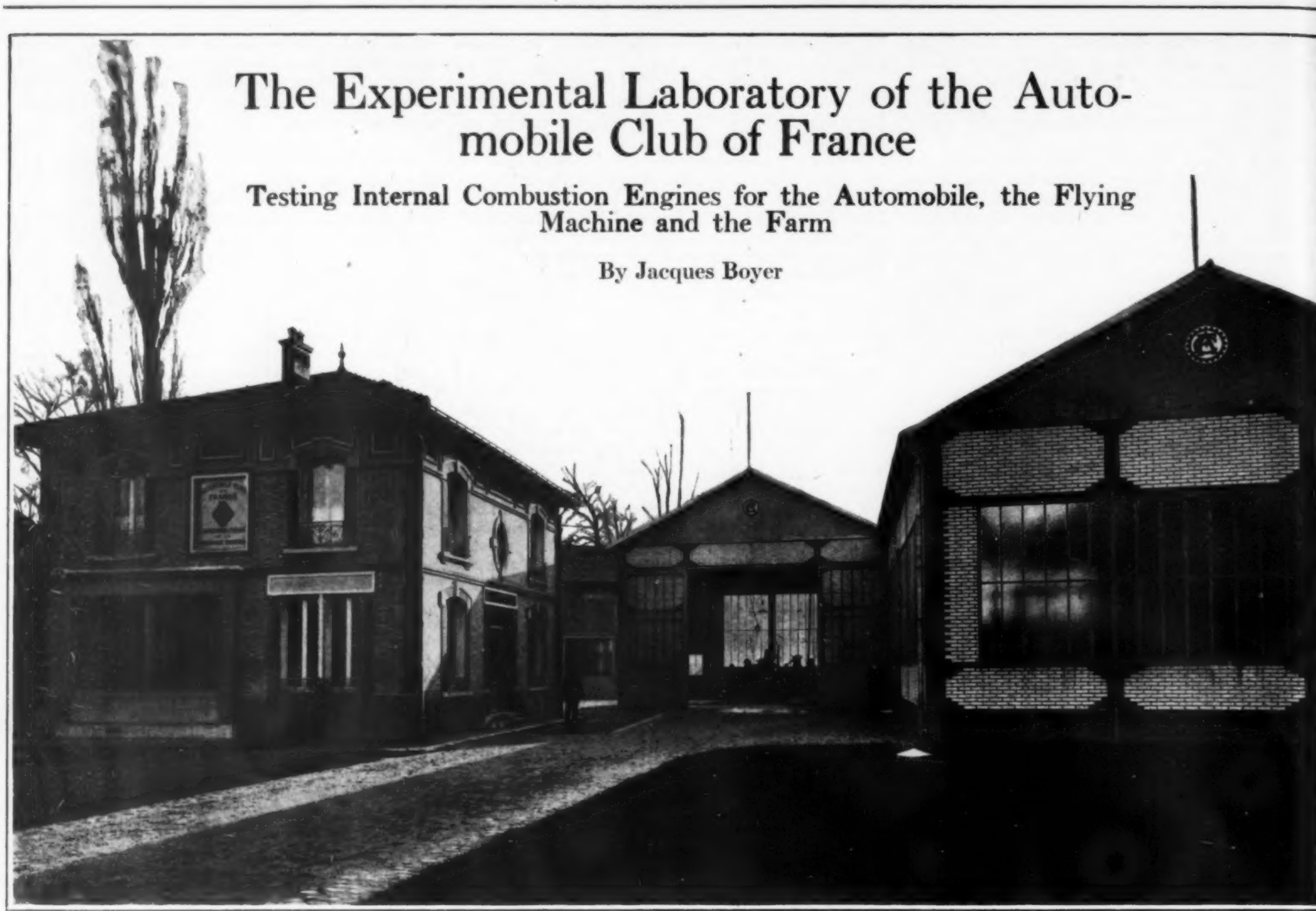


Fig. 1.—View of exterior of the new laboratory of the Automobile Club at Neuilly-sur-Seine, near Paris.

The Scientific American Supplement presents a description of the new laboratory at Neuilly-sur-Seine, near Paris, recently established by the Automobile Club of France. A somewhat full description is given, not because every feature in the equipment is new in principle, but because there is here gathered for the special purpose of investigation and research, a group of machines nowhere else assembled in a single structure. The laboratory is intended primarily for the study of internal combustion engines, not only for the automobile and flying-machine, but also for the navy, general manufactures and even agriculture. Besides the engines themselves, there will be tested combustibles, lubricating oils, etc., concerned in the development, transmission or utilization of power, in self-propelled vehicles, and the equipment will be capable of determining the physical and chemical constants of these substances.

Fig. 1 will serve to give an idea of the importance of the new constructions. The building to the left is the office with quarters for the custodian, and a social meeting place; the middle one has two laboratories for experiment, while the one to the right is a setting-up shop, to be used also for testing. The little hood in the grass at the corner of this building covers a ventilator for the escape of odors.

The laboratory building, of which the door is open, is fitted for investigations of many kinds. The floor has tracks for convenience in placing heavy machines. In the experiment represented in Fig. 2, an air propeller is being tried out. The thrust can be measured directly by the scales or registered, as shown on a Richard recorder.

Another test in the same laboratory is shown in Fig. 3, in which a Japy engine for producer-gas is under test with a familiar brake on the fly-wheel. The escape pipe for the gases runs up from the engine. The assistant is actuating a forced draught.

The importance of the establishment may be judged from the picture of the great shop (Fig. 4), which already has in place a number of machines for tests. The traveling crane has a capacity of two tons and is very convenient in its planning. There are in place three groups of coupled motor and dynamo, together with a lamp resistance. The engines shown are:

	I	II	III
	Dion-Bouton	Gillet-Forest	Renault
	1 cylinder	1 cylinder	4 cylinders
Diameter.......	3.3 inches	5.5 inches	2.5 inches
Stroke.........	3.5 inches	6.3 inches	4.7 inches
Speed..........	1,600	800	1,200
Horse-power....	4.5	10	10

The Gillet-Forest direct-coupled pair is shown in Fig. 6, together with an arrangement for a test. The voltmeter, ammeter and wattmeter are on the panel. A calorimeter—the long black cylinder below the meters—serves to measure the heat of the escaping gases, the measures of the heat being by electric couples whose wires rise at each end of the calorimeter. Other pieces of apparatus are a Forestier register on the stand, a Hospitalier-Carpentier manograph on the tripod, and on

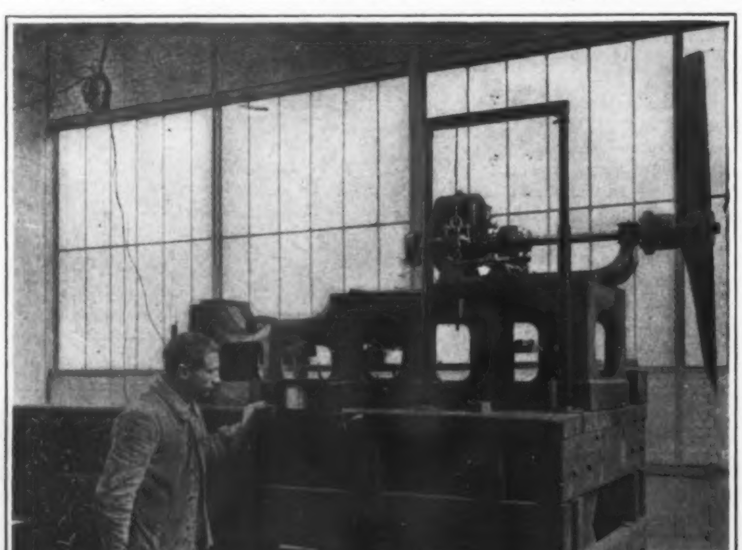


Fig. 2.—Trying out an air propeller. The thrust is measured directly by the scales or registered on a Richard recorder.

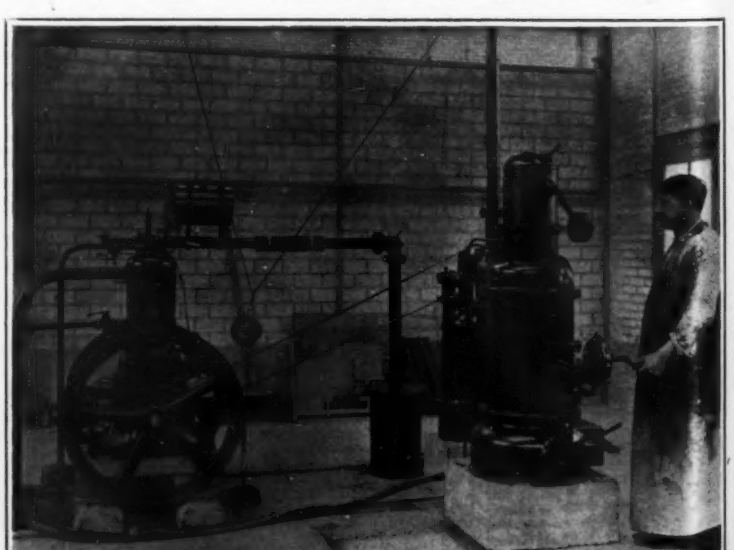


Fig. 3.—Japy engine for producer-gas under test, with familiar brake on fly-wheel. An assistant actuating a forced draught.

Fig. 4.—The great shop with testing machines in place. The traveling crane has a capacity of two tons.

the left the cans for gaging the water of the calorimeter.

Opposite the machine just described is the Renault motor, and beside this is a Sigma ten horse engine, braked by a Renard wheel outside the wall. A registering tachometer, devised by Ventoux and Duclaux, whose name it bears, is able to measure the speed of motors during very short intervals. On a strip of metalized paper rest two copper points, each held to contact by a spring, and each under the control of an electro-magnet. By an ingenious control involving a little motor in series with a variable rheostat, the paper strip is given a uniform motion of from one and one half to two inches per minute. The copper points trace parallel lines on the paper, which is treated with zinc, one of them broken every minute by an impulse from the clock, and the other by a contact made every thousand revolutions by a counter. It is necessary merely to scale the revolutions to the minutes to have the speed. With this recorder, it is possible to follow with great precision for hours the performance of the motors.

Behind the experimenting stands but exterior to the room are Renard fan dynamometers, protected from the rain by rounded roofs of corrugated iron and from the wind and meddlesome strangers by wooden doors. Fig. 7 shows their general disposition. These "moulinets" or wheels consist of two arms forming the diameter of a circle to which are fastened plates of aluminium. When the arms whirl, the plates being of known dimensions, the resistance may be figured, the exposed amount of surface and the distance from the center being factors.

The large setting-up room and experiment shop is already furnished with a second set of stands for measuring power by dynamometers of the electric cradle type.

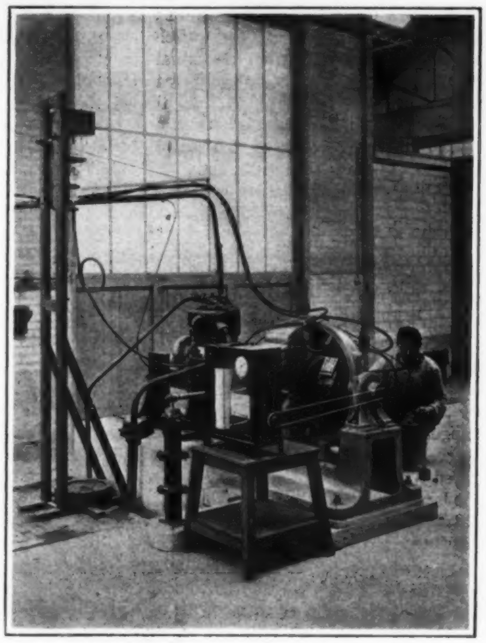


Fig. 5.—Cradle dynamometer for use in exact measurements of total liquid fuel consumption of motor during a very short time.

The method, which following the French custom assembles the names of its various suggesters, is termed the Panhard-Levassor-Hilliaret-Huguet, and it enables the investigator to measure very exactly the total liquid fuel consumption of a motor during a very short time. The fuel is supplied from a tank of known capacity, and every item is measured by means of the various indexes, some of which leave records (Fig. 5). In work of this kind it is advisable to limit as much as possible the length of the run, and it is necessary to maintain uniform speed throughout.

One of the motors under test at the time of this visit to the laboratory was a Cote 70 horse-power engine of marine type, while its neighbor is a Tony-Huber pump with accessories (First page). (The illustration is particularly useful in establishing the quality of the equipment, the reservoir, which is furnished with three calibrated orifices, being of unusually good workmanship for such purposes.)

The various benches of the laboratory are equipped with many conveniences. There is a special piping to conduct water for cooling the motors during action, there is usually a tank of water at hand, and a sink with overflow. The gases are caught by the drain pipes of the sinks, and outside the building they are collected into a reservoir whence an aspirator blows them into the air. Thus the motors work without the least noise.

For the determination of the co-efficient of friction, there is an apparatus devised or adapted by the director of the laboratory, G. Lumet. One cylinder turns within another. The interior one is furnished with segments that may be applied to the inner surface of the outer cylinder by means of oil pressure of known (manometer)

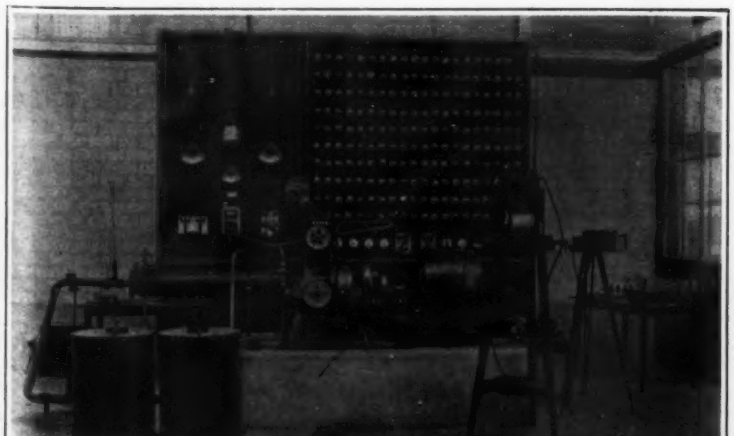


Fig. 6.—Gillet-Forest direct-coupled engine and dynamo, with an arrangement for lamp resistance test. Voltmeter, ammeter and wattmeter on the panel.

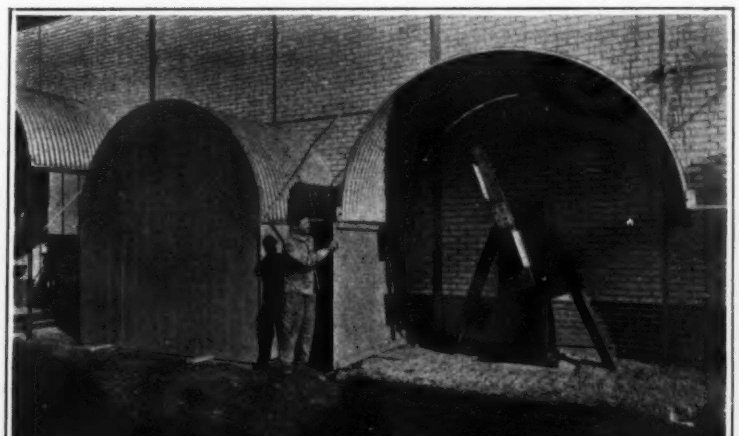


Fig. 7.—Disposition of round corrugated iron roofs for protection of dynamometers from rain.

amount. The friction is weighed on a beam scale of special pattern (the round bar in front of the machine). There are means of heating the cylinders together, and the temperature of the oil within and between the surfaces is determined by an electric couple.

The chemical laboratory determines principally the constituents of the residual gases, of combustibles and of lubricants, and makes other tests, among them, of the viscosity of the oils. The instrument on the floor is a viscometer of the Ventou-Duclaux pattern. It is probably more complete and convenient than other forms of viscosity measurers. The two cylinders on the stand are jacketed reservoirs or kettles. Both are open to the air and one is connected with the other by means of a pipe bearing a stopcock. Each reservoir has its thermometer, the lower one an overflow pipe and in addition an outlet centrally placed in the bottom, the metal of which is invar. This alloy has zero for its co-efficient of expansion, and furnishes, therefore, an aperture that is always the same size. This outlet is stopped with a plug.

The two jackets, which of course are closed, are connected one with the other and both of them with the third cylinder near the floor by means of large pipes, the whole outfit being heavily insulated against loss of heat. By this means the liquid in the jackets, which is an oil, may be heated to and maintained at any desired temperature.

The oil to be tested for viscosity, and this may mean at one or several temperatures, is introduced into the reservoirs, in the upper one to any desired level and in the lower one to the mouth of the overflow. The oil in the circulation system is then heated till the thermometers stand at the desired figure. At this moment the stopcock between the two reservoirs is opened and oil begins to flow into the lower one. Then as soon as the oil begins to run into the overflow the plug in the invar tube at the bottom is pulled and the oil flowing in one minute is caught in a vessel of known capacity.

Among the other pieces of apparatus in the laboratory may be noted the dynamometric balance for the testing of aviation motors, the stroboscopic tachometer, the Auclair accelerometer, which is useful in the study of modes of suspension of automobiles, and the Bourlet de Guiche vibrometer, which measures the vibration of the chassis.

This is not the first laboratory of the Automobile Club of France. In October, 1902, one was installed at Levallois-Perret, Seine, but presently the importance of the studies attracted attention and the quarters were found to be too small. Then the Syndical Chamber of Constructors, through the influence of its president, M. A. Peugeot, declared a vote of appreciation. Thereupon, with such encouragement the Automobile Club entered on the construction of the present establishment. The new laboratory was dedicated on November 3rd, 1913, in the presence of M. Etienne, Minister of War. There can be no question about its being of signal importance to the industries of France.

Safety of Life at Sea*

Vigilance Should Never Relax on the Supposition of a Vessel Being Unsinkable

As we reported at the time, the International Conference which originated in a suggestion made by the German Emperor, and which was convened by the British Government, to consider various questions pertaining to the safety of life at sea, was opened at the Foreign Office on Wednesday, November 12th last, by Mr. Sydney Buxton, President of the Board of Trade. The questions discussed by this Conference, which has sat almost continuously since that date, may be summarized as follows:

"(1) Is it possible by constructional arrangement—especially bulkheads and compartments—to decrease or to eliminate the liability to founder?

"(2) In the event of collision, fire, or other accident, what apparatus and machinery are required to minimize the disaster and to save the lives of those involved? This head covers the provision of boats and their accessories, and of other life-saving appliances; of fire-extinguishing appliances, and other apparatus.

"(3) What are the best arrangements to ensure the organized use of these life-saving appliances, so that they can be most effectively, coolly and expeditiously handled on board the ship herself, and on board a rescuing ship as well?

"(4) How can aid and assistance from another ship or from the shore be most quickly and effectively invoked and obtained?

"(5) What measures, apart from those connected with the vessel itself, can be taken to diminish or avert the likelihood of accident? Under this heading falls the observation of ice in the North Atlantic, the patrol of the ice regions, the observation and reporting of derelicts, storms and fog signals and warnings, etc."

The countries represented at the Conference were Australia, Austria-Hungary, Belgium, Great Britain, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Russia, Spain, Sweden and the United States.

Great Britain was represented on the Commission by Lord Mersey, Mr. M. E. G. Moggridge, Sir Archibald Denny, Sir Norman Hill, Sir John Biles, Captain Acton Blake, Captain Young, Mr. M. C. Hipwood, and Mr. M. W. D. Archer. Captain Loring, R.N., Captain Charles, R.N.R., Captain Campbell-Hepworth, R.N.R., and Mr. J. Havelock Wilson were employed as experts in a consultant capacity.

Lord Mersey was elected chairman of the Conference, and five sub-committees, together with a sixth subcommittee for drafting the Convention, were appointed. These, with their chairmen, were as follows:

Safety of Navigation Committee—Sir Norman Hill.

Construction Committee—Admiral Capps, U.S.A.

Radio-Telegraphy Committee—Mr. Moggridge.

Boats and Safety Appliances Committee—Sir John Biles.

Certificates Committee—Dr. von Koerner, principal German delegate.

International Drafting Committee—M. Guernier, principal French delegate.

The Commission held its final sitting on Monday last, when, as a result of its labors, the Convention, which has been arrived at, was signed. The actual text of this Convention will not be published till February 15th, but in a speech moving its acceptation by the delegates made on Monday last, Lord Mersey outlined its general scope at some length, and we are enabled to make the following extracts from the speech.

After briefly referring to the origin of the inquiry and the nature of the work carried out by the various committees, Lord Mersey proceeded to put before the Conference the general conclusions at which these committees had arrived. The Safety to Navigation Committee reported in the following manner:

SAFETY OF NAVIGATION.

"An International Service is to be established at the cost of the nations principally interested for the purposes of ice patrol, ice observation, and the destruction of derelicts in the North Atlantic, and it is proposed that this service be placed under the control of the Government of the United States. This service will take over and continue the work done by the two vessels employed by the United States during the ice seasons of 1912 and 1913 in locating the ice, in determining its limits to the south, east and west, and in keeping in touch with it as it moves southward, in order that vessels on the routes may be kept fully informed by means of wireless messages of the position of the ice. The service will also continue the ice observation work started last year by the British Government, with the object of ascertaining the set, the velocity, and the variations of the currents, and the manner in which the duration and rate of the ice drift is thereby controlled, with a view of determining before the opening of each ice season, and therefore before the ice has become a peril, the fundamental conditions which govern the movement of the ice. The service will be further entrusted with the duty of dealing with dangerous derelicts on the west side of the North Atlantic to the east of a line drawn from Cape Sable to latitude 34 north and longitude 70 west. The waters to the westward of this line will continue to be watched by the United States. To make the International Service more effective, the duty is imposed on the masters of all vessels of reporting by the best means at their disposal all dangerous ice and dangerous derelicts met with on their voyages. To make these recommendations effective a code has been prepared to facilitate the reporting from ship to ship and to the land stations, and the distribution of the information obtained over the vessels at sea. . . . It has not been possible to revise the International Collision Regulations, as many of the States, parties to those regulations, were not represented at the Conference, but the Convention binds the contracting States to bring about the revision of the regulations on five points, and re-examination upon other important points is recommended."

SAFETY OF CONSTRUCTION.

The report of the Construction Committee was then dealt with. It may be summarized as follows:

"In any consideration of the means for securing greater safety of life at sea, the type of the vessel itself and the character of its construction are of the highest importance. For the purposes of the Convention, vessels have been divided into two classes, viz.; (1) New vessels. (2) Existing vessels.

"The designation 'new vessel' is applied to all vessels, the keel of which is laid after the date on which the Convention goes into effect. The designation 'existing vessel' is applicable to all others. The provisions agreed upon are applicable in their entirety to all 'new' vessels, but, as regards 'existing' vessels, the Convention provides that 'existing arrangements . . . shall be considered on their merits by the Administration of the country to which each vessel belongs, with a view to improvements providing increased safety where practicable and reasonable.' The most difficult, and also the most important question considered under 'Construction' was that of the sub-division of ships into an adequate number of main water-tight compartments. The practicable degree of this sub-division is necessarily dependent upon the size of the vessel, and the service in which employed, and the Convention provides that the degree of safety should increase in a regular and continuous manner with the length of the vessel, and that 'vessels shall be as efficiently sub-divided as is possible, having regard to the nature of the services for which they are intended.' It is also explicitly stated that the requirements imposed by the Convention are minimum requirements."

Lord Mersey then went on to explain that it was quite impracticable for him to do more than make the briefest reference to this highly technical subject, but that the requirements as to sub-division were laid down *in extenso* in the Convention, and the Reglement annexed thereto. He then went on to say that among the other important subjects under the heading "Construction" which had been covered by this Committee might be mentioned the following:

"(1) Bulkheads for preventing the spread of fire.

"(2) Suitable means of escape from all water-tight compartments.

"(3) General requirements as to strength of water-tight bulkheads and decks.

"(4) Reduction to the smallest number practicable of openings in water-tight bulkheads; also restrictions upon the location, character, and means of closing such openings.

"(5) Restrictions as to the character, number, and location of openings in the ship's outer skin, and appliances for closing such openings.

"(6) Specific requirements as to the fitting and extent of double bottoms.

"(7) Periodical operation and inspection of water-tight doors, scuttles, valves and other appliances for closing openings in bulkheads and the hull structure below the bulkhead deck; also compulsory entries in the official log in relation to such drills and inspections.

"(8) Requirements for adequate backing power; also auxiliary steering apparatus.

"(9) Provisions for the survey and inspection of both 'new' and 'existing' vessels in all matters relating to the hull, boilers, main and auxiliary machinery, and equipment."

In concluding this summary of the provisions on safety of construction, Lord Mersey pointed out that, even after the most careful attention to all practicable details of design which increase the safety of a vessel at sea, there still remained the possibility of a serious and even totally destructive accident, and that it was therefore imperative that those charged with the management of vessels should never relax their vigilance on the supposition that any vessel was unsinkable. On the contrary, they should strive to add to the safety provided by the vessel itself that very great increase in safety which resulted from prudent and skillful management and navigation.

WIRELESS TELEGRAPHY.

Turning then to the findings of the Wireless Telegraphy Committee, Lord Mersey said:

"The Convention provides that all merchant vessels of the contracting States when engaged upon international (including colonial) voyages, whether steamers or sailing vessels, and whether they carry passengers or not, must be equipped with wireless telegraphy apparatus if they have on board 50 persons or more (except where the number is exceptionally and temporarily increased to 50 or more owing to causes beyond the masters' control)."

Then, after discussing certain exemptions and the classifications of vessels, the following provisions are made:

"A continuous watch for wireless telegraphy purposes is to be kept by all vessels required to be fitted with wireless apparatus, as soon as the Government of the State to which the vessels belong is satisfied that such watch will be useful for the purpose of saving life at sea; and meanwhile (subject to a transitional period for fitting wireless installations and obtaining the necessary staff) the following vessels will be required to maintain a con-

* Reproduced from *The Engineer*, London.

tinuous watch, in addition, of course, to all fast passenger vessels:

"(1) Vessels of more than 13 knots, which carry 200 or more passengers, and which make voyages of more than 500 miles between two consecutive ports.

"(2) Other vessels carrying 25 passengers or more during the time they are more than 500 miles from land.

"(3) Other vessels, required to be fitted with wireless apparatus, which are engaged in the Transatlantic trade, or whose voyage takes them more than 1,000 miles from land.

"The wireless installations must have a range of at least 100 miles and an emergency apparatus, placed in conditions of the greatest safety possible, must be provided unless the main installation is placed in the highest part of the ship and in the conditions of the greatest safety possible. The Convention provides that the master of a ship in distress shall have the right to call to his assistance from among the vessels which have answered his appeal for help the vessels which he thinks can best render assistance, and the other vessels which have received the call may then proceed on their way."

LIFE-SAVING APPLIANCES.

The Convention lays it down that there must be accommodation in lifeboats or their equivalents for all persons on board, and makes, among others, the following provisions:

"Lifeboats are divided into two classes: (1) the ordinary open boat, or other boats with fixed sides, and (2) boats having the upper part of the sides collapsible. The second class is rendered necessary by the consideration of stowage. Every vessel must be fitted with a minimum number of davits or equivalent appliances, which varies in accordance with the length of the ship. Each of these davits must have a lifeboat of Class I. attached to it, and thereafter additional lifeboats must be provided, until provision has been made either for a minimum capacity based upon the assumption that a maximum number of boats will be placed under each set of davits, or alternatively for accommodating 75 per cent of the total number of persons on board, whichever is the greater. If any further accommodation is required it may be provided either in lifeboats or in approved 'pontoon life rafts.' It is then provided that as large a number as possible of the boats and rafts must be capable of being launched on either side of the ship, so that as few as possible need be launched on the weather side. The Convention, further, lays it down that there must be a minimum number of members of the crew competent to handle the boats and rafts, and that all ships to which it applies must be efficiently and sufficiently manned from the point of view of safety of life at sea. All ships are to have an adequate system of lighting, so that in an emergency, the passengers may easily find their way to the exits from the interior of the ship. In new ships an independent source of lighting must be fitted as high as possible. The boats' decks must be well lighted."

MUTUAL ACCEPTANCE OF CERTIFICATES.

Lord Mersey then explained that the recommendations of the Committee which had dealt with this subject were exceedingly simple, and were, in effect, that the ships of the contracting States which complied with the requirements of the Convention should have furnished to them certificates of the fact, which should be accepted by all the States as having the same value as the certificates issued by them to their own ships, and as constituting *prima facie* evidence of compliance with the Convention.

GENERAL PROVISION.

In conclusion, Lord Mersey made some remarks on the work of the Informal Committee, of which he has been chairman. That Committee, it was explained, was concerned with what are termed "Dispositions Generales." These dispositions defined the ships to which the Convention should apply, the leading feature being that, except as otherwise provided, only ocean-going steamers carrying more than twelve passengers should fall within its provisions.

"There are, however, several exceptions to the above limitation, the most important being in the case of wireless telegraphy. Provision was also made for an interchange between the Governments of laws and rules relating to safety of life at sea and for the imposition by each of the Governments where necessary of penalties in case of neglect to comply with the provisions of the Convention. Further matters dealt with were the admission of other States which later on may wish to come under the Convention, the adherence on behalf of colonies of contracting States, the date (December 31st, 1914) by or before which the Convention must be ratified by the different States, and the date (July 1st, 1915) at which the Convention is to come into force."

The State of the Patent Office

The Annual Report of the Commissioner of Patents

The annual report of the new Commissioner of Patents, Mr. Thomas Ewing, contains a number of recommendations which are repetitions of those made by his predecessors, and also a number of recommendations which are entirely new with him. The report shows that we have at the head of the Patent Office a man with a thorough grasp of the patent situation, a man who realizes what reforms are necessary, not only from the Government's standpoint, but from the standpoint of the inventor and his attorney as well. The report is so lengthy that we cannot republish it in full here, but we should advise those of our readers who take a vital interest in patents to obtain it by writing directly for it to the Commissioner of Patents.

The more important passages are the following:

In 1913 there were received 68,117 applications for mechanical patents, 2,060 applications for design patents, 190 applications for reissues of patents, 7,369 applications for registration of trade-marks, 1,002 applications for registration of labels, and 391 applications for registration of prints. There were 35,624 patents issued, including designs; 164 patents reissued; and 5,065 trade-marks, 708 labels, and 290 prints registered. The number of patents that expired was 21,867. The number of allowed applications, awaiting the payment of final fees, was 13,567; and the number forfeited for non-payment of the final fees, 7,716. The total receipts were $2,084,417.79; the expenditures, $1,947,383.28; and the surplus of receipts over expenditures, $137,034.51. The total balance to the credit of the Patent Office in the Treasury of the United States on December 31st, 1913, was $7,297,052.46.

In proportion to population more patents were issued to citizens of Connecticut than to those of any other State—1 to every 1,152.

The total receipts of the office for the year aggregated $2,084,417.79. Of this amount $1,179,868.91 represents fees received by mail and express, the remainder having been paid by hand to the financial clerk. During the year, 194,101 amendments were filed. The number of letters, constituting the general correspondence of the office, indexed and filed was 249,021. In addition to this, 42,355 letters of inquiry were returned with circulars of information answering the questions propounded.

In the Assignment Division 30,288 deeds, containing 13,677,500 words, transferring title to patents, etc., were recorded, for which the office made a charge of $49,097.90. The number of deeds recorded in the year 1913 was larger by 1,772 than the number recorded in the year preceding.

About five years ago the work of printing the specifications of patents numbered below 32,000 was undertaken, and at this time all patents above 1,670 have been printed. In the near future the office will be able to furnish a printed copy of the specification and drawing of all patents, commencing with No. 1, issued July 28th, 1836.

The excess of receipts over expenditures during the calendar year ending December 31st, 1913, will be found by the detailed report to amount to $137,034.51. The surplus will probably be still larger during the coming year.

There is also an accumulated surplus of $7,297,052.46, as shown by the receipts and expenditures of the office since it was organized. In addition to this, there are 50,000,000 patent copies, constituting the working sets and copies for sale of all patents heretofore issued. These have been paid for out of the receipts of the office and therefore represent an asset in addition to the surplus. They sell to the number of about 8,000 per day, at 5 cents each, the total sales for the past year being 2,340,867. The receipts amounted to $118,043.35.

They therefore represent an investment beyond the surplus above indicated, having a value of nearly two and one half million dollars, so that the actual surplus of this office is close to ten million dollars.

The crowded condition existing in this office which has frequently been called to the attention of Congress is steadily growing worse. The patent copies kept for sale to the number of about 47,000,000 are scattered all over the office. This fact increases enormously the difficulty of getting them. Moreover, as they are stacked upon wooden shelves and are exposed, the danger of fire is very serious.

Plans were heretofore prepared and laid before Congress, on the basis of which an appropriation of $220,000 was granted to build a two-story structure in the court. This, in the opinion of the Secretary of the Interior and the officers of this bureau, would greatly impair the rooms opening on the court. No steps have been taken to carry out these plans. New plans have been prepared providing for a two-story structure under the present level of the court, practically fireproof. It is estimated that there will be room therein to store all the patent copies now kept for sale in the office and all accumulations for the next 15 years, and also that there will be storage room for such records as could not be replaced if destroyed. This structure could be built and equipped sufficiently for our present uses for the sum heretofore appropriated. The Congress is asked to grant authority to use the appropriation in accordance with these new plans. This structure will greatly relieve the congested condition in the office.

The valuable library is in present need of reorganization and enlargement. The collection of books, periodicals, and foreign patents is of the utmost value to the examining corps, inventors, manufacturers, and attorneys interested in investigating the novelty of inventions, but the material is not and never has been in condition for ready reference. Much of it is practically unavailable. The Commissioner has started the work of reclassifying and indexing with a view to meeting more nearly the peculiar needs of those who use the library. This library of about 75,000 volumes of scientific works and about 2,000,000 foreign patents, used as it is by people who are doing work which is almost identical with that of the examining corps, requires a librarian of special training and ability. General library training alone is not sufficient to enable one to understand the problems upon which those who use the library are working. The librarian should not only know library methods, but he should be trained in the art of searching. It is difficult to find anyone with the necessary qualifications for the $2,000 salary now provided by law. I believe, however, that by assigning a member of the examining corps and giving him opportunity of instruction of library methods in the Library of Congress, the best results obtainable can be secured.

To this end I should be given authority to detail members of the examining corps for a short time to the Library of Congress for special instruction in library work.

Moreover, as it is difficult to induce members of the examining corps who might be interested in library work to forego chance of advancement, the salary of the librarian should be increased to that of a principal examiner and the salary of the assistant librarians should be made to conform to those of assistant examiners in the different grades.

I greatly appreciate the aid rendered to this office by the Librarian of Congress and his chief classifier, looking to the reorganization of our library.

It has been suggested that instead of publishing in the *Official Gazette* selected claims, as is now the practice, there should be published a brief digest of the patents. These digests would be valuable to the examining corps and aids in searching. It would be necessary, however, to employ a corps of digesters large enough and highly trained enough to digest intelligently more than a hundred patents a day. The expense of this work would be largely, if not entirely, saved by the decrease in the cost of printing, since the digests would not be as extensive as the claims now printed. But the changes suggested, if deemed advisable, could not be put into effect without legislation providing for the necessary increase in the force.

On February 1st of last year, of the applications pending in the office, there were 26,195 which were awaiting official action. At the present time, January 31st, 1914, there are 28,437 cases awaiting official action, showing that the office has fallen behind about 2,200 applications. During the week when the examinations for promotions were held, there was a loss of 2,583 cases. As there are about 280,000 actions required in all cases pending each year, it will be seen that the loss in the number of applications during the examination week was about one half of a week's work. This loss can probably be avoided in the future, and if there should be no increase in the number of applications filed, the force can care for the current business as well as it is doing the work at the present time.

The more serious problem, however, is to bring the work of the office up to date, so that there shall be no unreasonable delay in passing upon an application after it has been filed. At present there are awaiting action as many new applications as are filed in two months and as many old applications as are amended in one month.

The number of applications awaiting action in the different divisions is very different, and the time required to reach an application for action in different classes is very different. Generally speaking, those classes in which there is greatest activity are those in which there is the greatest delay: and, it may be added, delays in such cases are of special hardship. Such delays can never be en-

tirely avoided, because sudden developments of activity in different classes occur, and the work in those classes falls seriously behind before new men can learn the particular art sufficiently for proper examinations of the applications. The Commissioner is endeavoring to make such improvement of conditions as is practicable with the present force. With the moderate increase in the force suggested heretofore, conditions could be very greatly improved.

An examination has been made in each of the examining divisions to ascertain the number of applications filed, as much as 15 years ago. Seventy-nine such applications have been reported as pending. This is considerably less than one in a thousand of all the applications now pending before the office. They have been prosecuted in accordance with the existing statutes, and it is not believed that any change of the statute which might be made to correct the evil of long delay in prosecution would destroy rights under any application now pending before the office. It has therefore seemed that the only practical policy for correcting the existing evil is to bring pressure on the examining force and the applicants and their attorneys to have old cases prosecuted to allowance or abandonment. With this end in view, the Commissioner has issued an order that all cases which have been pending before the office for more than eight years shall be made special, and to the end that there may be a uniform ruling applied to all such cases, he has directed that no amendment filed in any such application after June 1st of this year shall be entered without the approval of the Commissioner. He hopes to be able to make it impossible for an applicant to prosecute his application by dilatory or time-consuming amendments, by refusing to enter amendments which are not proper responses to office actions, and, in appropriate cases, holding the applications to be abandoned.

He is also considering the propriety and wisdom of making these old applications public. The statute contains no provision against it. There is, however, a rule of the office, under which they have all been filed, which declares that the applications shall be preserved in secrecy.

Little advantage will result from getting rid of the old cases now pending if others are permitted to take their places. With proper administration it is possible to limit the time during which an application may be kept pending in the office to less than five years and perhaps to less than three years, without unduly reducing the applicant's right to consideration of his case. However, as there are many thousands of applications now pending in the office which have been here over three years, the Commissioner has not found it physically practicable to treat them at once and I have therefore limited my order so far to those which have been in the office over eight years.

Few applicants who keep their cases in the office for many years deliberately are entitled to favorable consideration. It is believed that the consequence of the application of this conviction on the part of the Commissioner to the delayed cases will satisfy applicants of the wisdom of prosecuting their cases promptly. Every effort will be made to eliminate this evil of long-pending applications. If during the course of a year this has been substantially accomplished, it is believed that no legislation will be necessary to prevent the recurrence of the evil. Should efforts, however, along this line prove to be ineffectual, the Commissioner in his next report to Congress will recommend appropriate legislation.

In conclusion, it may be stated that on an average, applications are in the office about two years, and in the vast majority of cases this length of time is sufficient for thorough consideration of the applicant's claims.

Invention

INVENTION may be looked upon as the form in which imagination manifests itself in the engineer, and imagination may be defined as the power which some men possess of seeing a little further than their fellows. The course which invention takes cannot be clearly stated. At times it is the response to a direct call, as in the case of the locomotive, the steamship, the slide rest, Atlantic telegraph instruments, and so on. At others the invention is, in the first place, fortuitous. Just as the means of doing ill deeds makes ill deeds done, so, often enough, the sight of means of doing something useful, which has not been done before, leads to invention. Wireless telegraphy probably came about in that way. Herz had shown the possibility of transmitting electricity through the ether. His discoveries were of scientific interest, but they suggested a practical use to the inventive mind. Few scientific discoveries in these days escape the same treatment. The discoveries of Roentgen rays and of radium were not long known to the public before scores of patents were taken out for applying them for the use and benefit of man. With a little trouble one might produce a long list of inventions of a similar kind.

Which is the greater kind of invention—that which turns to use something which before has been only interesting, or that which meets a want by the use of known resources—it would be impossible to say. Indeed, the point is hardly worth pursuing, for the line between one kind of invention and another is often barely visible. It is more profitable to note that invention is the salient characteristic of the men who turn knowledge to useful purposes; hence it may be said that of all the qualities that an engineer should develop, that of inventiveness is one of the greatest. It has been suggested from time to time that invention classes should be held in technical schools, but the idea has, as a rule, been met with ridicule and derision. Men, it is said, do not invent to order, and there is no means of teaching men how to invent. We hold a different view. A very great deal of invention is done to order, and though much of it may be very bad, very indifferent inventing, it has its value as a training. There are many offices in England, in Germany, in France, in America, where a staff is maintained for the sole purpose of producing inventions. The methods followed in such offices cannot always be commended. For example, it is the practice in some hurriedly to invent a score of different methods of using some new scientific discovery or of meeting some newly arisen want and to obtain protection for all the inventions, untried though they be, with the object of "cornering" as many methods of achieving a desired end as the staff inventor can imagine. Such machine-made inventions are not to be placed in the same plane with the great inventions of the world; they smack too much of gambling. We mention them only to show that invention can be done to order, and that it would not be as impossible to teach students to invent as some people suppose. The difficulty in many cases would lie rather with the professor than with the students, and would be found in the matter of suggesting subjects of invention. But the difficulty is not insuperable. To the student with the real aptitude for engineering, however, a class is unnecessary; he cannot help inventing, and it needs no more than a little encouragement and a little help to make the mental training he gives himself of real value. The instructional value to be got from invention is incalculable. Take the case of the rotary engine, which has probably attracted the attention of young engineers more than any other single subject. It is not difficult to devise many different forms of mechanism which will cause a closed chamber to alter its volume, as some prescribed part or parts move in a circle. Having discovered such an arrangement the student must examine it from many aspects. He will be led to study the effects of centrifugal force, and may find exercise for his mathematics in effecting perfect balance; he will probably find that clearance is a stumbling block, and he will awake to the fact that it may ruin efficiency; he will be forced to consider in all probability such questions as live and rolling contacts, while he will be astonished at the influence of inertia even in light parts when he endeavors to accelerate them rapidly. Then when he has satisfied himself that such paper difficulties have been overcome he will have to consider manufacture. He will have to be in a position to say that each part can be made and that all the parts can be put together. Invention does not end, as so many people imagine, in an idea; it must be carried forward to the realization on a commercial scale and under commercial conditions of that idea. Our student, then, would be given the useful task of discovering the material value of his invention. He would be asked to show that it could be sold at least for as little, work at least as well, be at least as economical, and so on, as other engines. Then he would have to consider the condition of the market, the possibility of putting a new invention on it, the means of patenting inventions, and so on. In the making of the smallest invention there is a liberal education. We have taken as an example a rotary engine, but if it were only a hook and eye as much instruction could be sucked from it.

We would say, then, to all young engineers: "Develop in yourselves the art of inventing; invent anything and everything, and do not mind whether it is profitable or not; do not mind whether it is useful or not—a mechanical toy will give you almost as much training as a gas turbine— but invent, invent, invent. Keep on thinking out new ways of doing things and study them from every aspect. You will not only find that you will add to your own power, but you will discover in scores of cases reasons why improvements cannot be adopted. You will appreciate the fact that inventions have their commercial limits, and that the best way of doing something mechanically is not always the best way of doing it commercially. But, above all, you will develop the powers you may have of looking at the things around you in a new aspect, which is the beginning of greatness in engineering.—*The Engineer.*

The Origin of Petroleum

LEARNED men are not agreed as to the origin of petroleum. Two schools exist; one of which attributes the formation of petroleum to the igneous action of carbides on water; the other school considers that the petroleums proceed from a distillation of vegetable origin. Prof. Armand Gautier, following on the recent studies of MM. Aimé Pictet and Maurice Bouvier, which he has made known to the Academy of Sciences, gives the preference to the second hypothesis of a vegetable formation. The two learned Geneva gentlemen have distilled ordinary coal at a pretty low temperature, somewhere about [illegible] degrees in vacuum. They have thus obtained a special kind of tar vacuum, tar without any phenol or any aromatic hydro-carbides. Washed with alkali and sulphuric acid this vacuum tar treated by sodium gives a powdery product having a discharge of hydrogen. This body dissolved in water gives birth to semi-aromatic alcohols, derived from camphor and from hydrocarbides, having the formula $C_{10}H_{20}$, or $C_{12}H_{22}$, which have the same characteristics as the Canadian petroleums, the same point of fusion, same smell, etc. These are quite new experiments and of the greatest interest.—*Chemical News.*

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, FEBRUARY 21, 1914

Published weekly by

Munn & Company, Incorporated, Charles Allen Munn, President
Frederick Converse Beach, Secretary and Treasurer
all at 361 Broadway, New York

Entered at Post Office of New York, N. Y., as Second Class Matter

The Scientific American Publications

Scientific American Supplement (established 1876) per year	$5.00
Scientific American (established 1845) . . . . "	3.00
American Homes and Gardens . . . . "	3.00

The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application

Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 361 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

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